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ORIGINAL COMMUNICATIONS.

The Practical Use *of the* Microscope. By J. Hepworth.

(*Continued from* Vol. IV, p. 111.)

In making a post-mortem examination of a man about 63 years of age, who had laboured under gastric disease for two or three years and was extremely emaciated and dropsical, I found the stomach small, and containing about an ounce of yellowish mucus; there was no scirrhus, but the rugæ were thickened and more raised than natural, ecchymosis had occurred in different parts of the inner lining, but principally on the elevated ridges of the rugæ; the mucous lining over two or three of these spots had given way, leaving a small jagged ulcer. On examining one of these points I found that the vessels retained their form (although quite bare), except one or two, which had contracted and formed a knob about the $\frac{1}{400}$th of an inch in diameter at the point of rupture. There was a cicatrix, three quarters by five eighths of an inch in diameter, in which the muscular coat was wanting, but the mucous covering appeared to have been reproduced. On examining the mucus, it did not contain *Sarcina ventriculi* as I had anticipated, but some crystals of oxalate of lime (which I never met with in the stomach before), abundance of exudation corpuscles and what I conceive to be a vegetation (*vide* fig. 1). The corpuscles appear to have been the nidi of these formations, as I observed them in different stages of progress, as though each granule of the corpuscle supported a single cell, or plant; these becoming elongated, and so numerous as almost to hide the whole of the corpuscle from view.

The first appearance of any change in the corpuscle was the unusual development of the contained granules, as if they would start through the cell wall. They then assumed a light green colour, and appeared in the next stage either to have become further protruded, or had a cell added externally, which eventually became elongated into a semi-ellipsis of a very acute angle. The centre of the mass was of a brownish-olive colour; it had not a crystalline appearance, but each cell was more like the hair of a plant, being single.

On a superficial examination it appeared not unlike the crystals of lactic acid, but these cells were very different to

the long bundles of the crystals of that substance; the colour was also unlike, with both reflected and transmitted light.

On examining the lining membrane of the pelvis of the kidney, in the same subject, I detected a vegetation, which I shall, for want of a better, name *Sarcina renis* (*vide* Pl. I, fig. 2.)

About two years ago I met with a similar substance whilst examining some urine, but from its great similarity to one of the *Desmidieæ*, I concluded that it might possibly have got there by accident, and made no memorandum of it, except a sketch.

I find no notice of such a vegetation in Dr. L. Beale's excellent work on the microscope. In speaking of "matters of extraneous origin frequently met with in urine," he makes this very judicious remark, "With the microscopic characters of these bodies (giving a list at page 196) the student should be perfectly familiar as soon as possible, &c. Without this precaution he will find himself in constant difficulty, and his ignorance will cause him to make the most ludicrous mistakes."

There was no particular symptom indicative of the presence of these bodies, but in both the cases alluded to there was a general low state of vitality, as is always the case where vegetations are formed; for instance, in *Sarcina ventriculi*, aphthæ, &c. This reminds me of a sketch which I took some years ago of a specimen of aphthæ from a consumptive patient, which struck me as being peculiar (Pl. I, fig. 3). I am not aware whether it assumes this appearance in consumption invariably or not. The specimen (fig. 4) is a representation of the ordinary aphthæ in children.

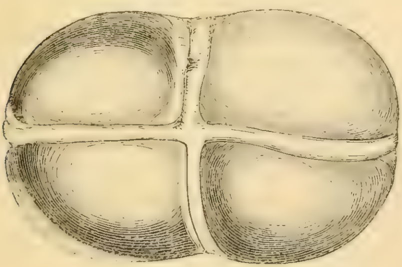
A boy, 13 years of age, with enlarged cervical glands, had complete obstruction of the bowels. There was hemorrhage, tympanitis, and occasional excruciating pain of the whole abdomen, stercoraceous vomiting, &c.

Post-mortem examination, fifteen hours after death.—The lumbar glands were enlarged, and had implicated the ileum immediately above the cæcum; small intestines very much increased, and large ones much diminished in capacity. In the immediate vicinity of the enlarged glands the intestines were not more than five eighths of an inch in diameter, and the obstruction was rendered still more complete by the protrusion of a mass of coagulable lymph inwards, arising from the condensed inner fibrous aponeurosis of the *muscular coat*, which was completely absorbed, leaving only cellular tissue containing a few vessels. There was general peritoneal inflammation and

all its consequences, effusion of serum, patches of lymph, &c. The peritoneum at the contracted part was very much thickened, brown, and scirrhous; the inner and outer fibrous aponeuroses of the muscular coat were also very thick, white, and dense, with transverse striæ (fig. 5), and appeared to have been pushed inwards considerably beyond the level of the mucous coat, which had been reflected on each side of the protruding mass. The accompanying sketch gives a general outline of a longitudinal section of the contracted part. The cellular tissue, which was left in place of the muscular coat, appeared to pass through the inner aponeurosis at intervals, probably opposite the valvulæ conniventes.

The following is a note of the case above mentioned:

J. S—, about 26 years of age, had difficult micturition, with anasarca of the extremities. The symptoms led me to examine the urine from time to time, in which I found what I called, it appears, at the time, *Sarcina vesicæ.* The urine did not coagulate on the addition of nitric acid. He gradually recovered as the general tone of the system improved. If this be the same vegetation as the other, it must be in a state of germination; it was about the same colour as the one sent. I took no measurement of it, therefore cannot say what size it is. You can make what use of it you please; perhaps a memorandum of it in a woodcut may cause others to be on the look out for similar specimens.



NOTES *of a* MICROSCOPICAL EXAMINATION *of* "MEASLED" *and other* PORK. By WILLIAM SMITH, F.L.S., Professor of Natural History, Queen's College, Cork.

THE subject of the present paper has of late excited much attention in this locality, the trade of the port of Cork and the industry of the neighbouring counties being immediately connected with the produce and export of provisions, a main portion of which consists of cured pork.

The disease in pigs popularly known as "measles" (though without any resemblance to the complaint bearing the name in the human subject) is one of frequent occurrence in the South of Ireland, and as its presence in the flesh of the animal is usually regarded as detrimental to its value as an article of food, the market-price of the commodity is thereby lowered, and the profits of the producer proportionally diminished.

Questions connected with the supply of provisions to the Crimean army having called increased attention to this subject, an attempt was lately made by the provision-merchants of Cork to arrive at more certain conclusions respecting the nature and extent of the disease, and its precise influence on the character and condition of the flesh affected by it.

Having been invited to assist in this research, by reporting on the microscopical appearance of the disease, and the meat affected by it, the following notes of a careful examination of fresh and cured pork, supplied to me, were my contributions to the inquiry:

The facts noted are not new to science, the subject having attracted the attention of several German, French, and British physiologists, and the results of their investigations being for the most part similar to my own.

The matter has not, however, been discussed in the 'Micr. Journ.,' and the following record of independent observation, and personal inquiry, may interest the readers of this magazine, and possess corroborative value when taken in connection with the more important investigations of other naturalists.

Nineteen specimens were supplied to me, viz.:

6 of healthy fresh pork from various parts of different pigs;
6 of fresh muscle, "slightly measled;"
6 of fresh muscle, "badly measled;"
1 of cured pork, "badly measled."

The "measles" are occasioned by the presence of a para-

sitic worm, known to physiologists and anatomists as the "*Cysticercus cellulosæ.*"

This worm, as it occurred in the muscle or flesh of the pork supplied to me, consists of an external bag or cyst of delicate rugose membrane, enclosing the animal of the *Cysticercus,* retracted within its folds; the space not occupied by the worm being filled with a clear watery fluid.

Pl. II, fig. 1, represents the natural size of the "measles" in fresh muscle; fig. 2 the same in stale or salted pork; and fig. 3 the same from fresh muscle, magnified 6 diameters.

The animal of the *Cysticercus,* when withdrawn from the cyst, within which it lies invaginated, and curled up, in all the specimens, consisted of a slightly enlarged head, fig. 4 *a,* and a neck formed of numerous rings, fig. 4 *b,* gradually enlarged into a bladder-like vesicle, fig. 4 *c,* which constitutes the body of the worm.

The neck and body of the *Cysticercus* are filled with a mass of minute transparent bodies, which a further examination leads me to regard as cellules discharging the function of assimilation, *i. e.,* converting the material endosmotically absorbed by the cyst and bladder-like vesicle into the substance of the *Cysticercus.* The form of these cellules is usually that of a flattened circular disc, and their average diameter $\frac{1}{1500}$th of an inch, but neither their size nor form is constant, some being linear, others irregular in outline, and many not exceeding $\frac{1}{3000}$th of an inch in diameter.*

The head of the *Cysticercus* is provided, at its extremity, with a circlet of about 24 hooklets (fig. 5 *a*), immediately beneath which are situated 4 circular organs, *b, b,* afterwards more fully developed in the mature condition of the *Cysticercus.*

The hooklets, upon further examination with higher powers of the microscope, are seen to consist of a stem fixed in the flesh of the head (fig. 6 *a*), a barb (fig. 6 *b*), and a sickle-like point (fig. 6 *c*).

The *Cysticercus,* as above described, constituting the "measles," is imbedded *between* the fasciculi of the muscle, and occupies a chamber formed by the inflation of its cyst.

The cyst which in a fresh state fills the entire chamber, on the death of the pig parts with its contained fluid, which permeates the surrounding tissues.

The chambers then collapse, and the muscle in consequence becomes soft, and flabby to the touch.

* [These elliptical bodies are composed in most part of carbonate of lime, and would appear to be intended more for the purpose of giving greater firmness or solidity to the part of the entozoon in which they occur than for any other function.—Eds.]

The "measles" in the specimens supplied to me were all visible to the naked eye, the cysts when inflated being of an elliptical form, and having an average length of about one third of an inch.

The coil of the enclosed worm was nearly globular, with an average diameter of about one tenth of an inch.

In the "slightly measled" pork the size of the worm was often less than in the "badly measled," but in every case the *Cysticercus* seemed to have reached the same degree of organic growth, and in none of the specimens, "healthy" or otherwise, could I detect the slightest trace of the animal in an earlier stage of development. Had the eggs, or young animals, existed, they could not have escaped my notice. In the specimens marked "healthy" there was no trace whatever of the *Cysticercus.*

The muscular tissues at a little distance from the cysts did not present any distinct alteration in their normal and healthy character, but in the immediate neighbourhood of the cysts there were evident traces of the altered or diseased condition of muscle known to physiologists under the name of "*fatty degeneration.*" Where the "measles" are numerous *fatty degeneration* would be proportionally great in comparison with the amount of healthy muscle.

In the salted specimen the cysts were empty of fluid, and the "assimilating cellules" in the body of the worm had become somewhat opaque, presenting a central granular nucleus instead of the clear transparent appearance noticed in the fresh specimens. I conclude from this that the life of the *Cysticercus* is destroyed by the process of "*curing.*" Fig. 7 shows the appearance of the assimilating cellules in the *fresh,* and fig. 8 in the cured specimens.

It is maintained by the most eminent physiologists of the present day, that the *Cysticercus* of the pig is the "scolex," that is, the intermediate or arrested condition of the "*Tænia solium,*" or tape-worm of man and other mammalia.

The organization of the *Cysticercus,* as above described, goes far to establish this opinion, and direct experiments instituted upon dogs and other quadrupeds fed upon fresh "measled" pork seems to place it beyond a doubt.

In the present case there was neither time nor opportunity to verify this theory by direct experiment.

The history of the early condition and future development of the *Cysticercus,* the pathological and hygienic deductions to be drawn from the above observations, and their bearing upon the wholesomeness or otherwise of fresh, cured, or cooked "measled" pork are questions which appertained to

the branch of the inquiry entrusted to my colleagues; I may, however, observe, that the microscopical examination here detailed would lead to the conclusion that the presence of the *Cysticercus* in the small numbers which occur in "slightly measled" pork does not appreciably affect the healthy condition of the muscular fibre, and that it is only when the numbers of this parasite are considerable that the fatty degeneration and watery condition of the muscles become apparent; and as it further appears that the operations of curing, or cooking, destroy the assimilating powers of the cellules, and consequently the life of the *Cysticercus*, it would seem that no apprehension need be entertained of tape-worm following the use of "measled" pork, provided the flesh be carefully cured or thoroughly cooked.

Description *of some* New Diatomaceous Forms *from the* West Indies. By Robert Kaye Greville, LL.D., F.R.S.E., &c.

Some months ago I received a box of shells from my friend Mrs. William Eccles, of Trinidad, among which was a small marine species covered with an entangled tuft of sea-weeds and zoophytes. This, as it appeared to contain *Diatomaceæ*, I manipulated in the usual way, and on careful examination found it to yield a number of exceedingly interesting kinds, especially if the very small quantity of the prepared material be considered. As it would scarcely serve any useful purpose to work out every form which presented itself in a gathering so trifling in extent, I propose to confine myself on the present occasion to the description of such as seem to be new; and I shall only mention that among the remaining forms worthy of notice the following were observed: *Synedra undulata*, Bail., *S. superba*, Kütz., *Cocconeis Grevillii*, Sm., *Navicula Hennedyi*, Sm., *N. crabro*, Eh.,* *Amphora obtusa* and

* As Professor Smith has not yet given a figure of this species, I can only conclude from his description, which most accurately agrees with the form before me, that I am correct in my reference. The figures engraved by Ehrenberg, in his 'Microgeologie,' Pl. XIX, fig. 29, are not satisfactory, especially *a* and *b*. The half frustule *c*, however, is probably the true form, with the faint moniliform structure of the striæ omitted, and the constriction far too widely concave. In the absence of authentic materials, I cannot venture to speak with any certainty of *Navicula pandura* of De Brébisson,

A. lineata, Greg., *Podocystis Americana*, Bail., *Climacosphenia moniligera*, Eh., *Rhabdonema arcuatum* and *R. Adriaticum*, Kütz., *Grammatophora hamulifera*, Kütz., *Asterolampra impar*, Shadb.

1. *Cocconeis punctatissima*, Grev. Valve elliptical-oval, densely areolato-punctate; striæ moniliform, concentric with the extremities, the moniliform structure ceasing within the margin so as to leave a simply striated border; median line dilated towards the extremities. Length of frustule 0·0020″ to 0·0024″; breadth 0·0012″ to 0·0015″. Striæ 20 in 0·001″. (Pl. III, fig. 1.)

Hab.—All the species in this paper are marine, from the Island of Trinidad.

One of the most beautiful species I am acquainted with, and closely allied to a new MS. species from the Black Sea, distributed by Professor Smith under the name of *Cocconeis Morrisii;* in fact, a mere cursory examination might readily leave an impression on the mind that the two were nothing more than varieties. A careful comparison, however, has satisfied me that they are truly distinct. The general outline is the same in both, but the striæ in *C. Morrisii* are coarser and far less numerous than in the West Indian Diatom. The beading is also much larger, more equal in size, and more separated. In *C. punctatissima* the beading, in consequence of the very numerous striæ, becomes more minute as it joins the median line, which latter presents the appearance of a rather broadly linear, indistinctly defined, pale space, dilated towards the extremities, where it terminates elliptically. In the single valves, which are most frequently met with, there is but one side, as it were, of the median line visible, which gives them a very peculiar aspect.

It is more difficult to separate this species by a written character from the variable *C. placentula*, although the

who defines the striæ as simply costate. Under these circumstances, I take the opportunity of offering an illustration of *N. crabro*, as it occurs in my Trinidad gathering, in the hope that it may be regarded as a faithful typical representation. The truth is, the group to which this species of *Navicula* belongs is one of great perplexity, and I trust that my friend, Professor Gregory, who is studying it, will do something towards clearing it up. The two forms which he has named *N. nitida*, Sm.? in the fourth volume of the 'Transactions of the Microscopical Society,' will probably prove to be the same as our present species, the moniliform structure having been perhaps overlooked from its extreme obscurity. As the name above mentioned does not occur in the second volume of Professor Smith's 'Synopsis,' that of *N. crabro* has doubtless been substituted for it. The outline and general character of Professor Gregory's *N.? pandura*, Bréb.? is also extremely similar to the Trinidad Diatom.

features are immediately appreciated by the eye. *C. punctatissima* is more uniform, and considerably larger; but the best mark is the conspicuous peculiarity of the median line, which in *C. placentula* is simple.

2. *Cocconeis crebrestriata*, Grev. Valve elliptical, delicately, closely, and uniformly punctato-striate; striæ concentric with the extremities; median line straight, simple. Length of frustule 0·0022″ to 0·0028″; breadth 0·0012″ to 0·0014″. Striæ 30 in 0·001″. (Pl. III, fig. 2.)

A well-characterised species. The striæ are numerous and closely arranged, with a faint appearance, requiring careful adjustment in order to render them distinct. Under higher powers the sculpture of the striæ exactly resembles ordinary cellular tissue, which under inferior powers causes the uniform oval-punctate appearance. Occasionally a border of the valve is indicated by a faint line, as seen in the figure, but this is not always apparent.

3. *Cocconeis inconspicua*, Grev. Valve nearly circular, border broad, rather strongly striated; disc diaphanous; striæ concentric with the extremities, faint, obscure in the centre. Diameter of frustule 0·0011″. Striæ at margin 22 in 0·001″. (Pl. III, fig. 3.)

This is a most delicate form, so transparent as to be very easily overlooked. The border being the most strongly marked, first catches the eye, appearing like a mere striated ring, until the median line and nodule be brought into focus. The striæ of the disc are perceptible for about a third of the space between the border and the median line, when they gradually become quite obscure.

4. *Campylodiscus fenestratus*, Grev. Valve nearly circular, the broad prominent border composed of a series of narrow cells; disc with four lattice-like sculptures formed by 3—4 bars crossing each other at right angles. Diameter of frustule 0·0023″. (Pl. III, fig. 4.)

No drawing can do justice to the exceeding beauty of this Diatom. The broad and prominent border is equal to about a fifth part of the whole diameter, and is composed of narrow parallel cells, which, at first sight, have the appearance of a double series, a deception arising from an undulation in the substance of the valve. Radiating striæ appear to pass from the border for a short distance towards the centre of the disc, which is occupied by four remarkable sculptures, exactly resembling square windows in miniature, the bars sharp and slender, and the panes actually appearing as if they transmitted light. The windows are not perfectly symmetrical, as some of the rows of panes are larger than others; never-

theless the resemblance is so perfect, that, if it were possible, they might pass for the reflection of real windows. The figure cannot give the effect of this, as the transparency of the valve is necessary to complete the deception.

5. *Campylodiscus Ecclesianus,* Grev. Valve nearly circular, the border composed of a double series of narrow-oblong cells; disc with two rows of short, broad, truncated bars, separated by a broad median line, from each end of which radiate a semicircle of fine striæ. Diameter of frustule 0·0024″. (Pl. III, fig. 5.)

Of this fine species, not less charming in the elegance of its sculpture than the preceding, the gathering furnished two examples. It is similar in size to the last, but somewhat more contorted, so that, when one portion of the valve is in focus, the details of the remaining portion are less visible than as they are represented in the figure. The valve is very concave. The central part of the disc occupied by the two rows of bars is nearly flat; but on each side of the rows and at their termination the disc is inflated; the lateral inflations being unsculptured, the terminal ones ornamented with striæ, which radiate from the ends of the median line, and stop before reaching the border, so as to form a semicircle. I am not aware of any known species which can be brought into comparison with this splendid form, on which I have conferred the name of Mrs. William Eccles, a lady who has most kindly collected for her friends many objects of natural history in the Island of Trinidad.

6. *Surirella eximia,* Grev. Valve linear-oblong, rounded at the ends, very slightly constricted in the centre; canaliculi delicate, about 18 on each side, reaching the narrow-linear, transversely striated median line, which is attenuated towards the ends, and becomes as narrow as the canaliculi. Length of frustule 0·0020″ to 0·0028″; breadth 0·0008″ to 0·0012″. (Pl. III, fig. 6.)

This extremely delicate and hyaline Diatom approaches *S. lata* in form, but differs in every other respect. The canaliculi are equidistant, and as fine as those of *S. gemma;* the alæ narrow, but conspicuous. A characteristic feature is the linear, transversely striated median line, which is gradually attenuated at each extremity, until at about the third or fourth pair of canaliculi from the end it becomes as slender as the canaliculi themselves.

7. *Navicula Gregoriana,* Grev. Valve elliptical-oblong, with abruptly produced and rounded ends; striæ obscurely moniliform, interrupted on each side by a longitudinal, linear, blank space, which slightly converges towards the central

nodule. Length of frustule 0·0024″ to 0·0038″; breadth 0·0010″ to 0·0014″. Striæ 25 in 0·001″. (Pl. III, fig. 7.)

A very striking and interesting species, of which I have seen two individuals of the sizes indicated in the specific character. Like others of the group to which it belongs, it would appear to vary greatly in its dimensions. It seems to be most nearly related to *N. clavata* of Gregory ('Trans. Micr. Soc.,' vol. iv. p. 46, Pl. V, fig. 17), which it closely resembles in general outline; but, as Professor Gregory has already remarked, there can be no doubt regarding the distinctness of the present form. The most conspicuous difference lies in the blank space which interrupts the striation on each side throughout the whole length of the valve. In *N. clavata* this space follows nearly the same rule as in *N. Hennedyi*, Sm., the outer boundary of the space corresponding with the curve of the valve. Whereas, in the Diatom under consideration, the blank space constitutes a mere linear band, running parallel with the median line, except at the centre, where it bends slightly towards the nodule. Between this space and the median line the interrupted striæ form also linear bands, which are continued into the produced extremities. The striæ are more numerous than in *N. clavata*, and very obscurely moniliform. Another species to which our new Diatom bears, at first sight, no inconsiderable resemblance, is *Pinnularia* (*Navicula*) *Couperi* of Professor Bailey, described in his microscopical observations made in South Carolina, Georgia, and Florida. ('Smithsonian Contributions to Knowledge,' vol. ii.) In that form, however, the ends are not suddenly produced, the sides are somewhat constricted, the striation is conspicuously moniliform, and the blank spaces, instead of running parallel with the median line, and terminating at the angle where the produced ends spring from the lateral curve of the valve, are gradually attenuated, and converge and terminate with the median line itself at the nodule. I have much pleasure in dedicating this fine species to my friend Professor Gregory, whose acuteness and perseverance have converted the unpromising sand of Glenshira into "diggings" rich in new and curious forms.

8. *Navicula compacta*, Grev. Valve broadly oblong, constricted at the sides, the shoulders much rounded, ends suddenly produced, obtuse; striæ becoming faint towards the middle, where they are stopped by a line running close to and parallel with the median line. Length of frustule 0·0010″; breadth 0·0006″. Striæ about 42 in 0·001″. (Pl. III, fig. 8.)

I am not aware of any described species which approaches the present minute form. The striæ are slightly radiate, and though quite evident at the margin, become gradually faint. The line which runs on each side, parallel with the median line, passes through the valve, as it were, to form the produced extremities.

9. *Pleurosigma compactum*, Grev. Valve linear-lanceolate. obtuse; flexure of the median line so great that it touches the margin, about midway between the central and terminal nodules, the curve following the same gradient to the extremity; striæ obscure. Length of frustule 0·0035″ to 0·0045″; breadth 0·0006″ to 0·0008″. (Pl. III, fig. 9.)

This *Pleurosigma*, of which I possess several specimens, is well marked by the excessive flexure of the median line, which is greater than in any species known to me, while the flexure of the valve itself as it is presented to the eye is so moderate, that a straight line drawn from the terminal nodules through the central one, passes considerably within the margin. From the point where the curve of the median line touches the margin, the latter, to the *furthest* extremity, is nearly straight, and is just perceived exterior to the curve of the median line, as the latter approaches the *nearest* end.

10. *Mastogloia minuta*, Grev. Valve elliptical-oval to elliptical-oblong, conspicuously apiculate; loculi 12 to 18; striæ very fine and close. Length of frustule 0·0008″ to 0·0010″; breadth 0·0004″. (Pl. III, fig. 10.)

Although I have seen numerous frustules of this minute Diatom, I have been unable to obtain a front view. As a species it is evidently allied to *M. apiculata* of Smith; but it differs in being scarcely half the size, and essentially in the much larger loculi. It is also much more decidedly apiculate, being generally even strikingly rostrate.

TRANSLATIONS.

Algarum Unicellularium Genera *nova et minus cognita, præmissis* Observationibus *de* Algis Unicellularibus *in genere.*

New and less known Genera of Unicellular Algæ, *preceded by* Observations *respecting* Unicellular Algæ *in general.* By Alex. Braun. (Leipsic, 1855; with six Plates.)

The author, after adverting to the important aid to be derived from the study of the lowest plants, and especially of the *Algæ,* and more particularly of their evolution, in the advance of our knowledge of the morphology and physiology of plants, and the establishment of a systematic arrangement of the vegetable kingdom, proceeds to some observations concerning unicellular *Algæ* in general, the substance of which is as follows:

Whether or not unicellular plants really exist, appears to be a question of no light moment towards the understanding of the gradation of Nature in ascending from the lower to the higher organisms, and especially towards the construction of a methodical arrangement of the vegetable kingdom in congruity with Nature, whose principles, as well as the correct appreciation of the nature of each plant, are chiefly to be sought in the study of the processes of evolution.

For our knowledge of the natural system of plants, which is daily increasing, indicates, in scarcely dubious terms, a parallelism between the primary divisions of the vegetable kingdom and the principal stages of morphosis presented in the development of each individual plant (that is to say, of those belonging to the more perfect class); and thus is shown a certain analogy between the vegetable kingdom and the organism of the individual plant, and the prevalence of a similar law of evolution proceeding by steps, in each.

It is well known that the primary germ and rudiment of the nascent plant is a homogeneous and indifferent substance, presenting scarcely any differences either in external form or internal constitution. In phanerogamous plants this is apparent in the formation of the embryo sac,* which is ultimately changed into the substance of the endosperm, and to

* That the embryo sac is the commencement of the future plant, besides by analogy, is proved by its nature, inasmuch as being disconnected from the parent tissues, and destroying by its own growth the texture of the surrounding cells, it leads as it were a parasitic life within the parent plant.

which, among the vascular cryptogams, the pro-embryo or *prothallium* corresponds. After fecundation, there arises from these transitory primordia another and principal series of vegetable generations, commencing from the embryo, and producing the vegetative *stirps*, by whose evolution in opposite directions the differences of *root, stem,* and *leaves* are produced. Subsequently, in the ascending portion of the *stirps* the morphosis of the plant is continued, and those stages of the process appertaining to the vegetative life having been established, it passes into a new stage by the formation of the *flower*, and by the intervention of the flower ultimately attains to the object of the whole vegetation in the production of the *fruit*.

A similar kind of gradation is exhibited in the vegetable kingdom taken as a whole. This begins, as is obvious, in the more simple plants, which present only trifling distinction of organs either external or internal, the root, stem, and leaves being either, as it were, fused together or ambiguous. They have neither flower nor any true fruit; the organs of fructification are closely connected with those of vegetation, and the act of fecundation, if any take place, is competent merely to excite, as it were, the first stage of evolution of the plant, since there is no succeeding generation whatever.

To this category belong the lower cryptogamous plants, aphyllous or simply cellular, and which have been, not inappropriately, termed by recent writers—*protophytes* or *thallophytes*. They represent, as it were, the pro-embryos of the higher plants, and constitute, in fact, the primordial vegetation in protogæan history, as well as in the existing economy of nature, forming the broad foundation of the whole vegetable kingdom.

This primary division in the natural system is succeeded by another, characterised by a heteromorphous, duplex vegetation, for a knowledge of which we are especially indebted to the discoveries of recent observers; for to the primary and transitional vegetation, that is to say, to a homogeneous prothallium, aphyllous and merely cellular, fecundation being completed in the prothallium itself, succeeds another, characterised by the distinct formation of external parts (stem, root, and leaves), as well as by the constitution of the internal texture composed of a mixture of cells and vessels. Thus from a lower stage the vegetation is advanced by successive generation to a higher, but without its ever attaining to the ultimate goal, inasmuch as plants belonging to this division, in which the progress of the metamorphosis is interrupted, and remains at the stage of a vegetative stirps, never arrive at the production of flower and fruit distinct from the vege-

tative formations. To this category belong the higher, vascular cryptogams, furnished with leaves, of which, according to authors, and also from the historical evidence supplied by geology, is constituted the second division of the vegetable kingdom, formerly the highest throughout the more ancient periods of the protogæan Flora. The term *cormophytes* might be employed to distinguish the plants included in this section.

The plants belonging to each of the above divisions, and which have conjointly, since the time of Linnæus, been termed *Cryptogamia*, all agree in the circumstance of their wanting flowers and true fruit, a character by which they were distinguished by those fathers in Botany who are esteemed by Linnæus as the first orthodox systematists—Cæsalpinus and Ray. These are succeeded by the floriferous or phænerogamous plants (*anthophytes*), which again, like the cryptogams, exhibit a binary division, according to the degree of evolution which they reach; for there are some in which the production of the flower commences, indeed, through a more exalted metamorphosis of the leaves, but is not fully completed, the carpellary leaves which constitute the true fruit enclosing seeds being deficient. As plants of this kind, which, though furnished with a flower, have no true fruit, are to be regarded the *Cycadeæ* and *Coniferæ*, which, formerly the subjects of futile and vain attempts at explanation, are now admitted without doubt to be gymnospermous, a truth for which we are indebted to the sagacity of Robert Brown. That the gymnospermous anthophytes really constitute a separate and independent group, by no means to be associated with the dicotyledons, with which they have hitherto been classed by most systematists, is proved by their habit,* the very incomplete structure of the flowers, the disposition and unusual form† of the stamens, and by the structure of the wood, but chiefly by the mode of generation, whose very manifest analogy with that of cryptogams has been excellently illustrated by Hofmeister. It is manifest, therefore, that they must be put in the lowest place, among the phanerogams, conterminous with the cryptogams, an arrangement which is favoured

* The habit of the *Cycadeæ* is manifestly filicoid, and that of the *Coniferæ* to a certain extent like that of the *Lycopodiaceæ*. The foliation of *Salisburia* can only be compared with the fronds of *Marsilia* and of some ferns (*Schizeæ*, *Adiantum*).

† Their disposition always in continuous spirals, never in determinate cycles (verticells); form more or less foliaceous and expanded; anthersiferous thecæ frequently numerous, whence a certain degree of resemblance to the sporanziophorous traits of *Lycopodium*, the sporophylls of *Equisetum*, &c.

not less by geological than it is by morphological considerations.

Another division, lastly, of phanerogams, in which the highest stage of the vegetable kingdom is reached, embraces all flowering plants which at the same time produce true fruit—angiospermous anthophytes; and in this section the subdivision into monocotyledons and dicotyledons is of secondary importance.

In what way the vegetable kingdom, as far as concerns the scale or gradation of evolution, agrees in general with an individual plant, may, with respect to the first commencement of the lowest step, be so specifically compared, that a law of analogy is clearly apparent in the accordance of the lowest plants with the lowest state of a higher plant. It is evident that every plant commences in a solitary and simple cell, either a spore or an embryo sac; it is clear also that the succeeding (succedaneous) generation originates in a simple cell (embryonic vesicle); the vegetable kingdom presents an analogous commencement; its lowest members are plants unicellular throughout their life—plants, that is to say, constituted of a single cell persistent through the whole period of evolution, and performing all the vital functions. The existence of unicellular plants of this kind has been long and frequently shown, though demonstrated by imperfectly known, and for the most part erroneous examples, until Nägeli laid a new foundation for the doctrine, in his careful illustrations of several genera of unicellular *Algæ*, and their classification according to a new method. But the limits within which that experienced observer circumscribed the unicellular *Algæ*, appear to the author too restricted, and scarcely such as should be closely observed; a circumstance which some have endeavoured to turn to the disparagement of the doctrine itself, going so far as wholly to deny the existence of unicellular *Algæ* at all, or even as to declare that the proposed genera were most of them the *primordia* merely of more perfect *Algæ* or of other plants, whilst others were said to be the ova of animalcules. It is scarcely worth while to attempt the refutation of these opinions, since they are unsupported by arguments derived from accurate observation, and because all who may enter with unprejudiced views into the vast domain of the lowest *Algæ* will be convinced that the truth is otherwise.

(*To be continued.*)

NOTES AND CORRESPONDENCE.

Note on Vorticella.—One evening watching an *Actinophrys Sol* procuring his supper, *more suo,* my attention was attracted to an object in another part of the field also feeding, but in a manner never before observed by me.

This was a common *Vorticella* (*Nebulifera*) feasting on a large jelly-like mass which much resembled the body of an *Amœba.* Instead of the ordinary, apparently rotatory, vortex-creating movements of the ciliæ, whereby food is usually brought to the œsophagus, ciliæ were seen protruded from within the oral aperture and applied, *as we would our finger and thumb,* in picking out from the gelatinous mass the oily-looking particles with which it was studded. After appropriating several of these, the creature would suddenly retreat, by the contraction of its pedicle, beneath a leaf of duckweed, from which, in a few seconds, it would emerge, again to renew its feast.

I continued to watch this proceeding until I had seen it repeated a great number of times; and I distinctly noticed that, as the highly refracting particles disappeared from the gelatinous mass, the body of the *Vorticella* appeared to become more and more charged with them.

Dr. Carpenter, in his recent work on the microscope, observes—"There is no reason whatever to believe that these animalcules (*Vorticellæ*) possess any organs of special sense." And again, "If they are really endowed with consciousness, as their movements *seem* to indicate, though other considerations render it very doubtful, they must derive their perceptions of external things from the impressions made upon their general surface, but more particularly upon their filamentous appendages."

I would merely remark that it is difficult for an ordinary understanding to dissociate the phenomenon here recorded, of this humble *Vorticella* selecting its food from corresponding actions in beings possessed of undoubted "consciousness"—difficult not to regard this diminutive creature, selecting its dainty morsels, even as a type of our own humanity.—H. Wilson, Runcorn.

Comatula rosacea—Encrinitic State.—In his recently published work on 'The Microscope and its Revelations,' Dr. Carpenter has announced the discovery of the young or encrinitic state of the *Comatula* in Lamlash Bay, where, he says, "it is so abundant that it may hereafter find its way into almost every cabinet." I have found it in the same locality, when dredging along the shores of Holy Island. Lamlash Bay, indeed, is rich in *Echinodermata,* yielding many of the finer species, and amongst them the beautiful *Echinus Flemingii.*

It may be interesting to some of the readers of the 'Journal' to know of a *southern* habitat for so great a rarity as the young *Comatula.* I have obtained it in abundance in Salcombe Bay on the Devonshire coast, between the end of July and the middle of September. It occurs profusely on sea-weeds, zoophytes, stones, &c. I have in my possession a bunch of weed from this locality which is literally covered with young *Comatulæ,* in every stage of development. Salcombe is on the South Devon coast, and about five miles from the town of Kingsbridge.—Thomas Hincks, Leeds.

Glaucoma scintillans.—The germs of this Infusorium exist in the atmosphere.

After boiling an infusion of chlorophyll (dried juice of cabbage and distilled water), in which I had been breeding *Glaucomæ,* but from which all traces of life had disappeared, I exposed the boiled solution to the atmosphere, and in less than a week tolerably large *Glaucomæ* were again visible.

Form.—*Glaucoma* changes its shape from that of an elongated oval in the earlier stage of its growth to various other forms.

I have not been able to discern an external integument; the internal substance of the body, which appears semi-fluid, solidifies towards the outer part as the animalcule increases in size. Possibly the cells may be developed in the centre, which always remains more liquid than the remaining portion of the body.

Internal structure.—Besides the vessels to be described, there are many small granules which, on minute examination, have the appearance of cells.

Glaucoma has no bowel.—What Professor Ehrenberg mistook for a winding canal is simply the vacant space between the internal globules, which sometimes presents that appearance when they are very numerous; at first sight it is very likely to deceive the observer.

The mouth is a slit or tear in the outer surface, it forms the wide entrance to a conical *gullet*.

I have crushed a great number of *Glaucomæ* with the covering glass, and on examining them immediately afterwards, some which were still alive had been torn open at the opposite side of the body, and food was entering there just as at the mouth.

The particles of food enter the gullet and accumulate at the pointed extremity. Whether they there are admitted into a cell ready constructed, or simply form themselves into a ball, I have not yet been able to see. But when the blue globule (in case indigo is employed to feed them) has attained a certain size, its own weight and the current from without seem to force it into the substance of the body. Here it remains fixed, and, with the exception perhaps of a slight change of position as the body becomes filled with globules, it does not move—certainly the food does not rotate.

The contractile vesicle is situated at the end opposite the mouth, and as the animalcule becomes developed a system of smaller ones, into which the fluid contents of the larger one are forced when the latter contracts, makes its appearance. If a young *Glaucoma* be dried up the contractile vesicle emits rays or beams, which widen as their distance increases from the central vesicle. Sometimes more than one large vesicle are visible. I have seen a discharging orifice in *Glaucoma*, but could not always distinguish one; probably one is always present.

Glaucoma reproduces by self-division. I have never seen any but *transverse* fissuration, and that frequently. That another reproductive process exists is certain from the fact that *Glaucoma* is developed from germs, and this, along with the further development of the animal, I shall endeavour at some further time to elucidate.—James Samuelson, Hull.

Colour of Blood Corpuscles.—In the description usually given of the *coloured corpuscles* of the blood, I discover an error which ought not to remain uncorrected.

Thus Kölliker ('Microscop. Anat.,' b. ii, p. 356), "Die Farbe der Blutzellen ist nicht roth wie die des Blutes, sondern blassgelb, und zwar aus physikalischen Gründen heller bei ganz abgeplatteten, etwas dunken bei mehr aufgequellenen zellen."

Henle also ('Anat. Générale, t. i, p. 457, trad. Jourdan, 1843) says that, "Les corpuscules coloris du sang se distinguent sur-le-champ par leur couleur jauneâtre."

Now I am perfectly aware that the above appearance is given by some authors as presenting itself under the microscope, but less distinguished writers make no mention of the condition under which the yellow colour is observed, and most elementary "text-books" of physiology for students convey the idea that the coloured corpuscles are actually of a faint yellow hue.

Now it stands to reason that no amount of *yellow* discs can produce the intense *scarlet* of human blood; on the contrary, I hold it as a positive fact that the colour of each particular flattened, circular, or oval disc of mammifer, bird, reptile, batrachian, or fish, is as deep and vivid as the mass of the blood of which it is a constituent part. The *scarlet* disc of man, when magnified by 500 diameters, fades almost to a pale straw colour; for, as you know perfectly well, the crimson that painted a surface the $\frac{1}{6\cdot8000}$th (about) of a square line is diffused over a superficial extent of not less than 2·10 square lines, which is a chromatic *dilution* of 142·800 times. It is not, therefore, surprising that the homœopathic quantity of red in the amplified image, besides *loss*, should hardly be recognised as such.

Suppose fl℥, 3·2, of fresh blood in a flat-bottomed glass vessel, 1·5 inch wide (cylindrical); the mass will have nearly the proportions of a blood disc, and a bright scarlet hue. Imagine, now, the same blood in a similar vessel, 750 inches wide, and thinned out with transparent syrup, of the specific gravity of the blood, until the mixed fluid would stand 150 inches high in the glass; would not this liquor, when viewed from above, give the same impression of colour to the eye as a single blood-corpuscle as seen "under the microscope," with a power of 500.

I beg to say, that I believe the error just pointed out in descriptions to exist only in the terms used, without care being had to explain why the *red corpuscles appear* faintly yellow; but this inadvertence is calculated to mislead professional men, and even some professors in this country, who teach physiology entirely from books.—Christopher Johnston, M.D., Baltimore, U.S.

Use of the Microscope.—The following case is so interesting a triumph for the microscope that I send it for your perusal, and insertion, if you please, in the 'Journal.'

A few days ago a medical friend told me of a patient who was then passing very large quantities of fat in her evacuations, and who had been doing so for a long time; he offered

to procure me some of the material for microscopic examination, and shortly afterwards I received a specimen. It seemed very similar in appearance to a coarse butter, was soft, and easily broken down, but it was dense, and sank in water. On examining it with a half-inch object-glass not a single fatty globule could be seen; neither did ether extract any oil. The mass consisted of a great number of large cells loosely aggregated, each had a clear transparent wall, without a visible nucleus, and contained a light brown granular mass, but which was separated from the cell-wall by a transparent medium. Average size of cell $\frac{1}{100}$th of an inch. It was clear that the material more closely resembled vegetable than animal structure, and the accidental discovery of a fragment of fibro-cellular tissue strengthened the idea. I then boiled a portion, and on the addition of iodine procured a dense precipitate of iodide of starch. My next step was to examine the mealy potato, as served at table. The size of the cells was the same, but all were empty, or filled only with a transparent fluid, and were puckered on the surface. The presence of the granular mass in the others seemed to indicate that the potatoes had been either uncooked or insufficiently boiled, the idea of their being taken *raw* seemed incompatible with the loose state of aggregation in which the cells were found. I hazarded the opinion that the patient ate largely of mashed potatoes, and evidently was a sufferer from a weak digestion, as she was unable to digest the starch they contained. I was then told that the case was one of long-continued dyspepsia, with an excessively irritable state of the stomach and bowels, that the lady could only take farinaceous food, and the doctor did not believe she took any potatoes in any way. The symptoms and "fatty" dejections had lasted for years. I assured my friend that there could be no moral doubt about the facts as revealed by the microscope, and next day I received a note from him to the following effect:

"Dear I.,—I have seen the lady, and you will be gratified to hear that for a very very long time she has almost lived upon mashed potatoes crushed small" (not boiled).

I need scarcely add a word upon the flood of light thus thrown by the microscope upon what otherwise would have been veiled in great mystery;—the facts speak for themselves. —T. Inman, M.D., Liverpool.

Conjugation of Diatomaceæ.—I have had a large stock of *Navicula amphisbœna*, in several gatherings, this summer from the Thames, at Weybridge, and have three times distinctly witnessed the following phenomenon, viz., what I suppose to be the formation of a sporangium by the joint conjugation of three and four frustules, as in Cosmarium, and some other species of *Desmidiaceæ*.

The frustules, three in two cases and four in the other, were attached to the sporangium by a short stipes proceeding from the centre of the lateral suture of each.

In two of the cases the endochrome had been discharged from all; the frustules in the third, in which four frustules were attached to the sporangium; one retained the endochrome, which entirely filled the lorica, and was of higher colour, and more condensed appearance than is presented by the species in its ordinary aspect.

Is it possible this frustule may have been antheridial? This is only an idea.

The sporangial frustule was marked in a series of nodules not unlike in appearance—though but just discernable with Ross's $\frac{1}{4}$-inch—the cells of a section of Echinus spine. I had not the good fortune to trace the development of the sporangium, having only seen it apparently near its perfection, nor have I, in consequence of leaving Weybridge, and my stock having been inadvertently thrown away, been able to follow its further history.—Thomas Charles Druce, Chelsea.

PROCEEDINGS OF SOCIETIES.

Microscopical Society, *May 28th*, 1856.

George Shadbolt, Esq., President, in the chair.

James Glaisher, Esq., Lewisham, was balloted for, and duly elected a member of the Society.

A Paper, by Mr. Wenham, "On the Vegetable Cell," was read.

June 25th, 1856.

George Shadbolt, Esq., President, in the chair.

J. S. Bolton, Esq., Brixton Hill; Hon. R. H. Meade, Belgrave Square; and the Rev. A. B. Cotton, Keppel Terrace, Windsor, were balloted for, and duly elected members of the Society.

A Paper, by Dr. Davey, "On the Structure of *Bryonia dioica*," was read.

A Paper, by the Hon. and Rev. S. G. Osborne, "On Vege-Growth in the Wheat Plant," was read.

A Report from the Committee on Finders was read.

ZOOPHYTOLOGY.

At the Meeting of the British Association, at Cheltenham, a "Notice," by Mr. J. Alder, was read of several new species of *Hydrozoa* and *Polyzoa,* found by him on the coasts of Northumberland and Durham. The entire number of species described amounted to thirteen, but we are here able to give only those belonging to the class *Polyzoa,*—four in number.

Class. Polyzoa.

Ord. *P. infundibulata.*

Sub-ord. *Ctenostomata* (*s. Vesicularina*).

1. Fam. *Vesiculariadæ.*

Gen. 1. *Buskia,* Alder, nov. gen.

Polyzoary corneous, consisting of a slender, tubular, creeping fibre, with cells developed at intervals. Cells ovate, adhering through their whole length; generally with lateral spine-like processes, also adhering; orifice terminal and circular. Polypide with eight tentacles, issuing from a sheath of fasciculated setæ.

B. nitens, Alder, n. sp. Pl. XIII, figs. 1, 2.

Minute, horn-coloured, shining; creeping fibre filiform, branching or anastomosing, with occasional short spinous offsets; cells ovate or flask-shaped, rather ventricose, tapering towards the orifice, the margin of which is thickened, and slightly nodulous; sides of the cells produced into irregular spines adhering to the substance on which it creeps. Length of cell, $\frac{1}{50}$th inch.

On *Plumularia falcata, Campanularia plumosa,* &c., from deep water, Northumberland coast, rare.

This interesting little zoophyte has probably hitherto escaped observation from its minuteness. The spine-like processes at the sides give the cells an insect-like appearance; they are irregular and occasionally wanting. The cells are also subject to some variation in form, especially in the size of the aperture; they lie nearly parallel to the stem, which frequently divides, and runs along each side of them, clasped by the lateral processes.

Farrella pedicellata, n. sp. Pl. XIV, figs. 1, 2, 3.

Body ovate-oblong, yellowish, transparent, with long and very slender pedicles, uniform in thickness throughout; tentacles 12. Length of cell, $\frac{1}{30}$th inch.

On old shells of *Buccinum undatum* and *Fusus antiquus,* from deep water, Cullercoats; not uncommon.

This species differs from the *Laguncula* (*Farrella*) *elongata* of Van Beneden, in the great length and slenderness of the pedicle, which is usually two or three times the length of the cell, and does not enlarge towards the top, as in the latter species. The cells are rather narrower above than in *F. elongata*, and the number of tentacles does not exceed twelve in any of the specimens that I have examined. The animal, as seen through the transparent cell-walls, is of a pale yellowish colour, with a brownish red patch, indicating the position of the stomach. The ovaries are white. The base of the cell is finely wrinkled, and at its junction with the pedicle it forms a kind of joint, which can be more or less twisted at the will of the animal.

2. Fam. *Alcyonidiadæ.*

Alcyonidium mamillatum, n. sp. Pl. XIII, figs. 3, 4.

Encrusting, semitransparent, brownish, covered with rather long, stout, and strongly wrinkled papillæ, from which the polypides issue; tentacles 16 or 18.

On old shells from deep water, Cullercoats; not uncommon.

When carefully examined this species can be readily distinguished from those hitherto known by the greater size and elevation of the papillæ, which, although varying much in length, according to their state of contraction, are always sufficiently prominent to be easily recognised. When most contracted they appear like strong mamillæ, but their more usual form, when the polypide is withdrawn, is elongate-conical; when it is expanded, they are cylindrical and nearly linear. This species is parasitical on old univalve shells, which it envelopes with a sub-coriaceous crust, never rising into a free state. No septa are visible excepting in the margin of young specimens, or when examined as a transparent object in the microscope.

Alcyonidium albidum, n. sp. Pl. XIII, figs. 5, 6.

Encrusting, semitransparent, yellowish white; general envelope inconspicuous; polypides prominent, ventricose, flask-shaped, sub-recumbent, becoming erect towards the aperture, which is truncate when contracted; tentacles 18.

Surrounding the stem of *Plumularia falcata* in small patches; from the deep-water fishing boats, rare.

This species looks somewhat like a cluster of separate animals; the polypides being prominent and united to each other by narrow septa, which are scarcely perceptible. When the polypide is extended it is columnar, tapering slightly upwards, and expanding into a slight ridge below the fasciculated sheath.

26

ZOOPHYTOLOGY.

DESCRIPTION OF PLATES.

Plate XIII.

Fig.

1.—*Buskia nitens*, highly magnified.

2.—Two cells of the same; the upper one showing part of the polypide with the sheath of setæ.

3, 4.—*Alcyonidium mammillatum*, natural size and magnified.

5, 6.—*Alcyonidium albidum*, natural size and magnified.

Plate XIV.

1.—*Farella pedicellata*, highly magnified.

2.—A cell with polypide withdrawn, more highly magnified.

3.—The same with the polypide expanded.

ORIGINAL COMMUNICATIONS.

MONOGRAPH *of the* GENUS ABROTHALLUS (De Notaris *and* Tulasne *emend.*) By W. LAUDER LINDSAY, M.D., Perth.

(Read before Section D. of the Meeting of the British Association, at Cheltenham, in August, 1856.)

THE genus Abrothallus, and especially the species hereafter described as *A. Smithii,* have long been familiar to lichenologists under a variety of designations; but their true structure and place in classification were quite misunderstood until the comparatively recent researches of De Notaris,* in Italy, and Tulasne,† in France. *A. oxysporus* (*infra descript.*) has generally been regarded as a species of *Endocarpon,* especially when it bore only young apothecia; while the apothecia of *A. Smithii* have been denominated *cephalodia,* and have been variously looked upon as the abortive, monstrous, or accessory apothecia of certain Parmelias, Lecideas, and other lichens, or as parasitic fungi. Sir William Hooker, in his 'British Flora,' vol. ii, p. 200 (1833), says that *Parmelia saxatilis,* and its variety *omphalodes,* "are liable to be infested with a parasite, which has been called *Endocarpon parasiticum,* Ach." ('E. Bot.,' t. 1866.) On furfuraceous states of *P. saxatilis* the Abrothalli are most abundant. In his 'Flora Scotica' (part ii, p. 44, 1821), Hooker gives as the characters of this *Endocarpon parasiticum* (*Lichen parasiticus,* 'E. Bot.,' t. 1866): "Thallus coriaceous, convex, rounded, lobed, copper-coloured, at length rugged, black and shaggy beneath, orifices scattered, sunk, minute, coal-black, at length convex." This description, in so far as it applies to the apothecia, appears to confound the two species *A. Smithii* and *A. oxysporus;* and, in so far as it describes a thallus, it is erroneous, since recent researches have proved the genus Abrothallus to be really athalline. The latter error, however, is rectified in the 'British Flora,' p. 159, where it is stated that the "*Endocarpon parasiticum,* Ach., is now universally considered to be a portion of the thallus of *Parmelia saxatilis* or *omphalodes* deformed by a parasite." The view

* 'Mem. della reale Accad. delle Sc. di Torino.,' ser. 2, vol. x, p. 351 (1849); and in 'Giorn. bot. Ital.,' ann. ii, fasc. iii-iv, part i, p. 192, (1846).

† "Mémoire pour servir à l'Histoire organographique et physiologique des Lichens," in the 'Annales des Sciences Naturelles,' ser. 3, Botanique, vol. xvii (1852), p. 112.

that the Abrothalli are abortive apothecia of certain familiar foliaceous lichens is maintained so lately as 1850 in Schærer's elaborate 'Enumeratio critica Lichenum Europæorum,' (Berne, 1850). He describes the species mentioned by Hooker as *End. parasiticum*, under the name of *Parmelia saxatilis*, var. *parasitica*, in the following terms: "Thallo supra apotheciis abortivis, atris, subpatellæformibus vel hemisphæricis, immarginatis, consito." His description of the var. *abortiva* of *Parmelia conspersa* is precisely similar. Of *Parmelia olivacea*, var. *abortiva*, he says, "Thallo supra sphærulis atris (apotheciis abortivis) distincto." These are characteristic descriptions of *A. Smithii*, the variety which I have hereafter described as *α*, *ater*. To my variety *pulverulentus* of the same species, he refers, sub nom. *Sticta fuliginosa*, var. *abortiva*, when he says: "Thallo supra patellulis superficiaribus, olivaceo-viridi-pulverulentis, immarginatis, distincto." Schærer's specific and generic characters have too evidently been founded wholly on external appearances: he himself deplores his deficient microscopical knowledge and skill. But he does not appear to have been aware of—or at least he does not allude to—the researches of De Notaris on the genus Abrothallus, which bear date between the years 1846 and 1849,—prior to the publication of his own 'Enumeratio.' Of Tulasne's investigations he could not avail himself, as they were published two years subsequently. By other observers, again, there has been too great a tendency perhaps to take for granted the bold and sweeping assertion of Fries that "Lichenes in aliis parasitici normaliter nulli genuini,'—an assertion whose incorrectness the labours of subsequent observers have sufficiently proved. It has been too much the custom lazily and ignorantly to refer minute, black, point-like or spot-like parasitic lichens to the great family of the Fungi; but I feel assured that many species of Sphæria, Dothidea, Peziza, and other fungi, presently so-called, which are parasitic on the thallus of various familiar lichens will ultimately be found to belong themselves to the ranks of the lichens. I attribute, however, no blame to my predecessors for having erred in regard to the structure and place in classification of these minute organisms. Nay, I do not see how such errors could have been avoided; for the parasitic lichens, to which I refer, could not have been properly studied prior to the introduction of the microscope. I believe it to be too common now-a-days to depreciate the labours of the earlier botanists; but the more we study the minuter Cryptogams the more must we become convinced of the extent, accuracy, and value of

their observations. Most of the organisms with which we are now acquainted were noticed and described by them; and we cannot hold them altogether responsible for the misinterpretation of their nature and alliances.

While studying the furfuraceous and other abnormal states of the thallus of the common *Parmelia saxatilis*, in various localities in the neighbourhood of Perth, during the past spring, I was struck by a peculiar deformation or anamorphosis of the thallus, which I first found in abundance on a damp, shady, old wall on Craigie Hill, Perth. An examination of the lichen soon convinced me that the deformation was the seat, if it was not also produced by the growth, of a parasitic lichen, and that this parasite consisted of the *Abrothallus Smithii*, *A. Welwitzschii*, and *A. oxysporus* of Tulasne. The unusual interest connected with this genus on many accounts led me to look carefully for it in similar habitats elsewhere. I have since succeeded in finding these species in comparative abundance in many parts both of the Highlands and Lowlands, more especially of the former. I have recently examined microscopically about 250 specimens, chiefly from Highland districts, comprising both species in every state and stage of growth. In the majority of cases the habitat was old roadside walls—chiefly built of rocks or boulders belonging to the primitive or metamorphic series. In a comparatively small number of instances, the matrix grew on loose boulders of the same rocks; and in a still less number on trees, especially the ash and alder. In all cases the parasites grew on furfuraceous forms of *P. saxatilis*. From the frequency with which I have gathered the Abrothalli in the Highlands and Lowlands of Scotland, I have no hesitation in asserting that, if carefully looked for, they will probably be found comparatively common in Wales and Ireland, and—to a less extent perhaps—in England,—especially the hilly parts thereof. In addition to the Abrothalli collected by myself, I am indebted to the kindness of the Rev. W. A. Leighton, of Shrewsbury, for specimens,—chiefly of *A. oxysporus*, growing on *Cetraria glauca* and *Parmelia conspersa*, as well as on *P. saxatilis*, from Barmouth, North Wales. And lastly, I possess, in Leighton's 'Lichenes Britannici exsiccati' (fasc. ii, No. 46), specimens of *A. Smithii*, Tul., growing on furfuraceous states of *P. saxatilis*, from the Wrekin, Shropshire; and (fasc. vi, No. 191) of *A. Welwitzschii*, Mont., on *Sticta fuliginosa*, from rocks, New Cut, Meadfort, Torquay, Devonshire. These specimens have therefore afforded me ample facilities for investigating, by the aid of the microscope and chemical reagents, the anatomy of the

genus Abrothallus. My results, though in the main corroborative of the admirable descriptions of Tulasne, lead me to take a somewhat different view of the numbers and characters of the species; while they enable me to rectify or supply various of his minor errors of commission or omission. For example, Tulasne speaks of the "Spermogoniæ ignotæ;" and, so far as I am aware, no previous or subsequent author (for, in Körber's 'German Lichenography,' published during the present year, the spermogones are stated "in der gewöhnlichen Form bei Abrothallus zu fehlen scheinen" *) has observed, or at least described, the spermogones of Abrothallus, which I have been fortunate enough to meet with several times. But I have other and perhaps stronger grounds for bringing the anatomy of Abrothallus under the notice of British botanists. It is destitute of a thallus; is parasitic on another living lichen; and is possessed of the accessory reproductive bodies, *stylospores,* contained in conceptacles resembling in structure and site the spermogones, and termed by Tulasne *pycnides.* In each of these respects, the genus is peculiar and deserving of special study. I believe that a knowledge of the origin, structure, and mode of development of the deformations of the thallus of *P. saxatilis,* on which the Abrothalli grow, will assist us in explaining the nature of certain so-called erratic lichens, which have been lately discovered. British botanists have very recently been much puzzled to account for the origin of a curious globular Parmelia, found by Sir W. C. Trevelyan, bowling freely before the wind along the surface of the soil on the exposed chalk downs of Dorsetshire. A careful examination has led me to the conclusion that this wandering Parmelia is merely a hypertrophied condition of the deformed thalli in question. Until within the last few years, botanists were almost unaware of the existence of lichens parasitic on other species. Even yet our knowledge of parasitic lichens is exceedingly incomplete. The list of British species is very meagre; but the patient labours of such men as Leighton, of Shrewsbury, and Mudd, of Cleveland, are daily adding thereto. As illustrations of British parasitic species, it will suffice here to notice the occurrence of *Calicium turbinatum, Lecidea inspersa,* and *Acolium stigonellum,* on *Pertusaria communis: Scutula Wallrothii* and *Celidium fusco-purpureum* on *Peltigera canina: Celidium*

* 'Systema Lichenum Germaniæ. Die Flechten Deutschlands (insbesondere Schlesiens) mikroskopisch geprüft, kritisch gesichtet, charakteristisch beschrieben und systematisch geordnet von Dr. G. W. Koerber.' Breslau, 1856.

Stictarum on *Sticta pulmonaria* and *S. scrobiculata*: *Phacopsis varia* on *Parmelia parietina*: *Phacopsis vulpina* on *Cornicularia vulpina*: *Arthonia glaucomaria* on *Lecanora glaucoma*: *Verrucaria rimosicola* on *Lecidea rimosa*: *Lecidea vitellinaria* on *Lecanora vitellina*: and *Sphinctrina septata* on *Thelotrema lepadinum*. We doubt not that botanists have only to direct attention to parasitic lichens in order to discover many new and interesting species. There is a wide field open here for scientific research: we are but on the threshold of the inquiry. Körber most truly remarks (p. 216):

"Es öffnet sich hier ein ebenso für die Physiologie, wie für die systematik der Flechten überaus reiches Feld der Beobachtung, dessen Grenzen vor der Hand noch nicht abzusehen sind, und dessen fleissige Bearbeitung uns einst über die Verwandtschaft der Flechten mit gewissen Pilzordnungen genügendere Aufschlüsse geben wird, als bis jetzt gegeben werden konnten."

The presence of stylospores and the absence of a thallus tend to assimilate the genus closely to the Fungi. We are daily finding closer links between the great families of Lichens and Fungi; and the shades of distinction, the marks of differentiation, in the lower tribes of both are becoming less conspicuous. It were well, therefore, that the lower or more minute, and hitherto little-known lichens should be studied cotemporaneously by lichenologists and mycologists, or by botanists possessing an intimate knowledge of the structure and affinities of the Fungi as well as of those of the Lichens. Standing as they do on a debateable and ever-shifting border ground, their just claims in regard to their position in the scale of vegetation can only be decided by a species of scientific arbitration. Hitherto too many of the lower lichens have been claimed as fungi. Lichenologists are now making raids among the ranks of the latter, and there is a danger that, in their too eager search for deserters, or animated by a spirit of retaliation, they may seize plants which do not properly belong to them. Moreover, it is highly desirable that British microscopists should take up the subject of the minute anatomy of the lichens, and especially of their reproductive organs. With the exception of the elaborate works of Mr. Leighton of Shrewsbury, we have nothing to place in competition with the monographs of Tulasne, Montagne, De Notaris, Flotow, Nylander, Massalongo, and other Continental observers. And lastly, I gladly avail myself of the opportunity of illustrating, in a single small and comparatively unknown genus, the chief

forms of reproductive organs in lichens which have been hitherto discovered and described.

Tulasne describes the five following species of Abrothallus, viz.:

1. *A. Smithii.*
2. *A. Welwitzschii.*
3. *A. microspermus.*
4. *A. oxysporus.*
5. *A. inquinans.*

It appears to me that, probably from an examination of a limited number of specimens, Tulasne has created an unnecessary number of species, which I think admit satisfactorily of being reduced to two. The reasons which lead me to propose such a reduction will appear more fully in the subsequent analysis of the structure and character of the species, so far as I have been enabled to examine them in Scotch, Welsh, and English specimens. Meanwhile, I would state here that Tulasne does not appear to have made sufficient allowance for differences in minor characters produced by variations in habitat, when we consider that the Abrothalli grow on lichens so opposite in their habits as *Parmelia saxatilis, P. caperata, P. conspersa, P. olivacea, P. tiliacea, Sticta fuliginosa, Sticta sylvatica,* and *Cetraria glauca.* I cannot regard the characters on which he has founded the differentiation of the first three species above mentioned as sufficient or satisfactory. I shall, therefore, include them under the same species, to which I shall retain the name of the first—*A. Smithii.* But, while Tulasne's characters are insufficient to separate the lichens which he describes as *species,* they are, to a certain extent, characteristic of *varieties.* The more prominent of these characters, so far as they accord with my own observations, I propose to preserve under the varieties *α, ater, β, pulverulentus,* and *δ, microspermus,* of *A. Smithii.* The fourth species, *A. oxysporus,* appears a most natural one. The fifth species, *A. inquinans,* which Tulasne designates a "species recedens," I would discard as not properly pertaining to the genus under consideration. It appears more to belong to *Celidium* or an allied genus. It differs from the two species of Abrothallus hereafter to be described—1st, in its apothecia being superficial or epithalline, and not bursting through the cortical layer of the matrix; 2d, in these apothecia being minute and arranged in orbicular patches, the central ones confluent in deformed maculæ; 3d, in the form of the spores, which more resemble the oval stylospores of the other species; and 4th, in its occurring on a tartareous thallus, the sterile crust of a Bæomyces. In the description

of the amended characters of the genus Abrothallus, and of the species *A. Smithii* and *A. oxysporus*, I have retained the names originally bestowed on them by De Notaris and Tulasne, not because I prefer them as peculiarly appropriate; but because I am averse to increase the "confusion worse confounded" of lichenological nomenclature by altering old and conferring new names, where it is not absolutely necessary. A complex synonymy has too long been a stumbling block to the lichenological student. I cannot, however, omit to notice here the faultiness of the generic term originally proposed by De Notaris (*Abrothallus*, from ἁβρός, thin or delicate, in allusion to a supposed thin or delicate thallus), he having mistaken deformed portions of the thallus of *P. saxatilis* for the proper thallus of the parasite. Tulasne has proposed a name, which is less objectionable, viz., *Phymatopsis*, from φῦμα, a tuber, and ὄψις, like; but I prefer retaining the first for the reasons just stated.

The insertion here of the amended characters of the genus *Abrothallus*, and of the species *A. Smithii* and *A. oxysporus*, —so far as based on my own researches,—will facilitate the subsequent details of minute structure.

Körber arranges the genus Abrothallus in the sub-family Biatorineæ, of the natural order Lecideaceæ; and the structure of the apothecia appears to me to justify his classification. He only, however, describes the species *A. Smithii* and *A. microspermus*, the latter of which I shall show is to be regarded as only a variety of the former; and he removes the other species described by Tulasne out of the genus *Abrothallus*, from which they are distinguished by their very different spores. He does not appear to have had full opportunities of studying them; for he speaks of them as hitherto unobserved in Germany. Hence his decision is based on insufficient grounds.

Gen. *Abrothallus*, De Notaris emend.—Species athalline; parasitic on the thallus of various foliaceous lichens. *Apothecia* developed in medullary tissue of matrix; burst through, sometimes fissuring in a radiate manner, the cortical layer, which may form a raised border; finally seated on, or partially immersed in, the alien thallus; at first flattened or discoid, sometimes becoming pulviniform or globose; immarginate; circumference agglutinated to matrix or free; smooth or pulverulent; mostly black. *Hypothecium* brownish or greenish. *Thecæ* eight-spored, clavate, becoming obovate; amyloid reaction with iodine often inconspicuous or absent.

Paraphyses closely aggregated; thickened, deeply coloured, and cohering at their apices. *Spores* ovate-oblong and obtuse at ends, or ellipsoid and acute; two-locular—the loculi being unequal in size, and the larger one always looking towards the apex of the theca—or simple; of an olive-green or brownish colour, or pale; frequently containing two or more globular nuclei. *Spermogones* immersed, spherical, one-locular, opening by a point-like or stellate-fissured ostiole; envelope of a deep brown tint. *Sterigmata* simple, slender, irregular; generating from their apices only, linear, straight, slender *Spermatia*. *Pycnides* also immersed, spherical, one-locular, opening by a simple or stellate ostiole, generally larger and more conspicuous than the spermogones. *Sterigmata* short, simple, sometimes inconspicuous or absent; monospored, generating from their apices, the stylospores, which are pyriform or obovate, simple, pale, obtuse at ends, and contain an oily protoplasm or distinct oil globules.

Species I.—*A. Smithii,* Tul. emend. (including the *A. Smithii, A. Welwitzschii,* and *A. microspermus* of Tulasne, and the *A. Bertianus* and *A. Buellianus,* De Not. and Massol. Ricerch., 88. *Biatora Parmeliarum,* Fw., in litt. Smmf. Lapp., 176 [sub. Lecid.] *Endoc parasit.,* Ach., Syn. 100. Fw., L. E., 451). *Apothecia* epithalline, scattered, rarely confluent, prominent, pulviniform or globose, normally smooth and black, sometimes green-pruinose; circumference agglutinated or free; ultimately falling out and leaving distinct cyphelloid foveolæ, which have frequently raised and dark margins. *Hypothecium* olive-coloured. *Thecæ:* amyloid reaction with iodine feeble or none. *Spores* ovate-oblong (Körber describes them as soleæform or "schuhsohlenförning"), two-locular, upper segment broader and shorter than lower, olive-green or brownish; vary in size; loculi frequently containing one or two globular nuclei. *Spermogones* absent. *Pycnides* abundant.

α. Var. *ater.* Apothecia black and smooth. (*A. Smithii,* Tul. in part.)

β. Var. *pulverulentus.* Apothecia sparingly or copiously green-pulverulent. (*A. Smithii,* Tul. in part, and *A. Welwitzschii,* Tul. Leight. L. E. fasc. vi, No. 191.)

δ. Var. *microspermus.* Spores small and pale. (*A. microspermus,* Tul.)

Habitats.—1. On furfuraceous states of *Parmelia saxatilis:*

generally associated with *A. oxysporus*. In a large proportion of cases, varieties α and β occurred on the same specimen. Sometimes, however, var. α predominated or was found alone,—for example, on dry exposed walls in Highland districts, or on boulders on Highland mountains. At other times, var. β was the more abundant form, chiefly on damp and shady roadside walls, both in Lowland and Highland localities. The var. δ, in which, according to Tulasne, the spores are all small and pale, I have not met with.

A. On walls: in Highland districts, built chiefly of granite, gneiss, mica slate, and other primitive or metamorphic rocks; in Lowland districts, built chiefly of basalt, greenstone, porphyry, amygdaloid, or other members of the trap series, of new or old red sandstone, &c.

1. Craigie Hill, Perth; with pycnides. Trap, primitive and metamorphic rocks.
2. Birnam Hill, Dunkeld; with pycnides. Clay slate series, including hornblende and chlorite slates.
3. Craig-y-Barns, Dunkeld; with pycnides. Mica slate series.
4. Amulree road, Strathbraan, Dunkeld; with pycnides. Clay slate and mica slate.
5. Highland road between Blairgowrie and Percy; with pycnides. Gneiss.
6. Highland road between Percy and Spittal of Glenshee; with pycnides. Gneiss and quartz rock.
7. Glenshee, Glen Beg, and Glen Clunie, between Spittal of Glenshee and Braemar; *pycnides* more abundant than in any other station. Mica, hornblende, and chlorite slates; gneiss and quartz rock.
8. Road between Braemar and Corramulzie Linn; with pycnides. Gneiss.
9. Glen-tilt road, about Linn of Dee; with pycnides. Quartzose mica slate, and gneiss.
10. Deeside road, near Invercauld, Braemar. Gneiss.
11. Ben Lawers, Loch Tay; with pycnides. Mica slate.
12. Banks of Crinan Canal. Gneiss, mica and clay slates.
13. Road between Sligachan and Portree, Isle of Skye; with pycnides. Syenite, greenstone, compact felspar, amygdaloid and other trap rocks.
14. Great northern road, Uig, Skye; with pycnides. Trap rocks, chiefly amygdaloids, basalts, and greenstones.

15. Road between Dumfries and Caerlaverock; with pycnides. New red sandstone.*

B. On boulders, or rocks *in situ*, on Highland and Lowland hills: on the former, it is usually found at low elevations, that is, towards the base of the higher Highland mountains; on the latter, it occurs at all elevations.

1. Moors to the west of Braemar; with pycnides. Gneiss.
2. Craig-choinich, Braemar. Granite.
3. Mor-chone, Braemar. Granite.
4. Loch-na-gar, Braemar; with pycnides. Granite.
5. Glen Dee, Braemar. Granite.
6. Ben Nevis. Mica slate, gneiss, granite.
7. Moncrieffe Hill, Perth. Basalt, greenstone, amygdaloid, and other trap rocks.

C. On trees: the ash.

1. Road between Dumfries and Caerlaverock; with pycnides.

D. Special habitats unknown.

1. Wrekin Hill, Shropshire. (Leighton's 'Lich. Brit. exsicc.,' No. 46, fasc. 2.)
2. Barmouth, North Wales. (Rev. W. A. Leighton.)

II.—On *Sticta fuliginosa.*

1. Rocks, New Cut, Meadfort, Torquay, Devonshire. (Leight. 'Lich. Brit. exsicc.,' No. 191, fasc. 6, var. β. [sub nom. *A. Welwitzschii,* Mont.])

In addition to the habitats which I have given above, Tulasne mentions the occurrence of *A. Smithii* on *Parmelia olivacea, P. tiliacea,* and *P. omphalodes,* in France. I have never met with it on any of these species. I should doubt its occurrence on *P. omphalodes;* and suspect that a dark-coloured form of *P. saxatilis* has been mistaken therefor. Körber also gives *P. olivacea, P. tiliacea,* and *Cetraria glauca* as habitats for it in Germany. On the latter I have seen *A. oxysporus,* but not *A. Smithii.* Var. β, Tulasne's *A. Welwitzschii,* is stated by him to occur on *Sticta sylvatica,* on the Serra de Cintra Mountains, Portugal.

* The geologic age of this sandstone is disputed, some authorities regarding it as properly the old red, and anterior in date to the coal series.—*Vide* Nicol's 'Geology of Scotland,' p. 43.

Spec. II.—*A. oxysporus*, Tul. emend.—Apothecia not prominent, chiefly immersed, flattened or discoid, blackish-brown, generally crowded. *Thecæ:* amyloid reaction with iodine distinct. *Paraphyses:* tips light brown. *Spores* ellipsoid, acute at ends, colourless or pale yellow, normally containing two yellowish globular nuclei placed towards the opposite extremities of the spore. *Spermogones* somewhat rare. *Pycnides* absent.

Habitats.—I. On furfuraceous states of *Parmelia saxatilis;* generally associated with *A. Smithii* at most of the localities already mentioned.

A. On walls:

1. Craigie Hill, Perth; with spermogones.
2. Birnam Hill, } Dunkeld.
3. Craig-y-Barns, } Dunkeld.
4. Strathbraan, } Dunkeld.
5. Highland road between Percy and Spittal of Glenshee; with spermogones.
6. Glenshee, Glen Beg, and Glen Clunie, between Spittal of Glenshee and Braemar; with spermogones.
7. Road between Braemar and Corramulzie Linn; with spermogones.
8. Deeside road, near Invercauld, Braemar.
9. Banks of Crinan Canal.
10. Road between Sligachan and Portree, Skye.
11. Road, Uig, Skye.
12. Road between Dumfries and Caerlaverock.

B. On boulders, or rocks *in situ:*

1. Moors to west of Braemar.
2. Craig Choinich, } Braemar.
3. Mor-chone, } Braemar.
4. Glen Dee, } Braemar.
5. Ben Nevis; with spermogones.
6. Loch Coruisk and Glen Sligachan, Skye. Trap rocks, porphyry, syenite, amygdaloids, &c.
7. Moncrieffe Hill, Perth.

C. On trees: the alder.

1. Glen Nevis.

D. Special habitat unknown:

1. Barmouth, North Wales (Leighton); with spermogones.

II. On *Parmelia conspersa.*

1. Barmouth, North Wales (Leighton); with spermogones.

III. On *Cetraria glauca.*

1. Barmouth, North Wales (Leighton); with spermogones. Körber also speaks of it as abundant on *C. glauca* in Germany.

In the earliest state in which I have observed them, the deformations of the thallus of *P. saxatilis,* on which the Abrothalli grow, occur as minute, simple, orbicular squamules, smooth above, black-fibrillose below. If they are studded over with the young apothecia of *A. oxysporus,* they greatly resemble the scale-like thalli of some Endocarpons. They are very different in appearance from the laciniæ of *P. saxatilis,* which are sinuate-lacinulate, and the lacinulæ divaricate-angulose with retuse extremities. They are epithalline, seated upon the ordinary thallus of *P. saxatilis,* from which they appear perfectly distinct. Hence such squamules have the appearance of separate and parasitic vegetations. Occasionally I have seen the Abrothalli growing on the normal laciniæ of furfuraceous forms of *P. saxatilis,* or on laciniæ very slightly modified. In other cases, the anamorphoses, in the structure of their laciniæ, closely resemble the ordinary thallus of *P. saxatilis.* Occasionally a few scattered apothecia of *A. Smithii,* with its pycnides, occur on simple squamules; but this is comparatively rare. With age these squamules undergo great modifications, and it is generally at a somewhat later period of development that they become the sites of the Abrothalli. The first change consists in their becoming lobed and polyphyllous; in this condition they not unfrequently resemble the var. *complicatum* of *Endocarpon miniatum. A. oxysporus* often inhabits thalli of this kind. This condition is well marked in specimens of *A. oxysporus* from Glen Nevis. Sometimes the lobes or squamules preserve a concavity of surface; more generally they acquire a convexity from a tendency to evolution or curling out of their edges, which in some cases are much thickened. The surface is occasionally much corrugated or pitted, and scattered over with grayish soredia or warts, which frequently crown the ridges of the plicæ. I have also seen the squamules pruinose like the thallus of *Parmelia pulverulenta.* In some cases—as in *A. oxysporus,* from Loch Coruisk, Skye, and in *A. Smithii,* growing on the

ash on the roadside between Dumfries and Caerlaverock—I have found cubical or octohedral crystals more or less abundantly in the thallus, apparently consisting of the carbonate or oxalate of lime. I have frequently detected crystalline matters of various kinds in the thallus of other lichens.

The colour of the squamules varies greatly in different habitats and localities. Sometimes they possess a peculiar leaden hue; such squamules, whether simple or polyphyllous, are generally sterile, or they bear pycnides scattered sparingly towards the margins and unassociated with apothecia. In Highland districts especially, the thallus is sometimes of a rusty red or copper colour, depending apparently on the absorption of peroxide of iron. This species of coloration is frequent also in the ordinary thallus of *P. saxatilis.* At other times the squamules have a light brownish tint on the surface; but the medullary tissue, as exhibited in fissures of the cortical layer, or in the foveolæ left by the falling out of the apothecia of *A. Smithii,* possesses a brilliant saffron tint, resembling that of the under surface of *Solorina crocea.* In other cases, the colour approximates that of the thallus of *P. saxatilis,* on which the deformations occur.

The thalli on which *A. Smithii* is parasitic generally become globose, irregular, gnarled masses, from the evolution of the edges already alluded to, and from the development of successive and super-imposed crops of new lobes or squamules. This convexity increases; the base of adhesion becomes narrowed by continued curling; and the globular mass may at length be easily detached from the thallus of *P. saxatilis,* to which it bears little or no resemblance. The most globular or hypertrophic specimens I have met with have been sterile forms of a leaden hue or light grayish colour, apparently developments of the squamules on which the pycnides of *A. Smithii* frequently occur alone. A section shows such a mass to consist of a series of irregularly disposed layers of squamules or lobes, separated by alternate strata of a brownish granular matter, the débris of the rhizinæ or black fibrils of their under surface. I have never seen these masses free; but, from a consideration of their mode of growth, I have no doubt that they may be ultimately detached by the wind or other agencies, and, continuing to vegetate in the way I have described, may become regularly globular, all trace of the base of adhesion being obliterated. In a specimen of *A. oxysporus,* on *Cetraria glauca,* from Barmouth, North Wales, for which I am indebted to Mr. Leighton, the parasite grows on peculiar bullose dilatations of the extremities of the laciniæ, or of some more central portion of the thallus of the Cetraria.

These peculiar deformities appear to arise as pustules of the thallus, which gradually become distended and inflated, till they assume a bladder-like form. At the same time, their base sometimes becomes altered into a narrow peduncle, apparently by a process of contraction in the surrounding tissues, and a pyriform or globular bulla is produced. By continued contraction of the base of adhesion the mass may become free; the peduncle may disappear, and a regularly globular form be produced. In such a state these bladder-like bodies of extreme lightness would readily be carried great distances by the wind, and might accumulate in particular localities. This is doubtless Schærer's var. *bullata* of *C. glauca*, of which he says ('Enum. Crit. Lich. Europ.,' p. 13, 1850): "Thalli lobulis extremis in capitula inflata transformatis." These pustules or bladder-like dilatations must be regarded as morbid conditions of the thallus, produced by the growth of the parasites. They are analogous to the blisters caused on the leaves, and excrescences from the bark or stems of various of the higher plants produced by the attacks of insects. But it does not appear to me that the anamorphoses of the thallus of *P. saxatilis*, on which the Abrothalli grow, can be placed in the same category. They are neither dilatations of, nor excrescences from, the parent thallus, but distinct and superimposed, sometimes easily detachable, growths. I think, therefore, that Körber has taken an erroneous and limited view of the subject when he observes: "Die stellen des Imbricarien- und Cetrarien-lagers, welche von diesem Parasiten überwüchert werden, bilden eigenthümliche bauschige Anschwellungen, welche das durch den Schmarotzer bedingte Kränkeln der Mutterpflanze deutlich verrathen, früher jedoch als eigne Lager dem Parasiten fälschlich zugeschrieben wurden (p. 216); (speaking of *P. saxatilis*, p. 73): auf den eignen Lager eigenthümliche kleinlappige, krankhaft aussehende und mit dem parasitischen Abrothallus Bertianus besetzte Polster bildend; (and of *P. caperata*): des Lager der Imbricaria caperata wird von diesem Parasiten (*A. microspermus*) weniger krankhaft verändert" (p. 216.) His error probably arises from his not having carefully studied the origin and development of these anamorphoses in any considerable number of specimens. In the Braemar district I have not unfrequently met with globular dilatations or excrescences of the thallus of *Lecanora tartarea*, *L. parella*, *L. ventosa*, and other lichens, unassociated with any parasitic growths. Nor have I ever seen such dilatations or excrescences in *P. saxatilis*, on whose normal laciniæ, as I have already stated, the Abrothalli sometimes occur.

The deformations of the thallus of *Parmelia conspersa*, on which *A. oxysporus* grows, as examined in specimens from Barmouth, communicated by Mr. Leighton, more resemble those of *C. glauca* than those of *P. saxatilis*. In Welsh specimens of *A. Smithii* and *A. oxysporus*, growing on furfuraceous forms of *P. saxatilis*, the portions of thallus on which the parasites occur have more the character of the ordinary laciniæ of *P. saxatilis* than in Scotch specimens. The thallus of *P. saxatilis* in these specimens is whitish, friable, and mealy, compared with Scotch ones, which are tough and coriaceous. This difference is probably to be accounted for by differences in the geological character of the habitat.

In addition to the other irregularities of structure or appearance already alluded to, I have occasionally observed, particularly in Highland specimens, the cortical layer of the deformed thalli partially or wholly eroded, apparently by insects, the subjacent white or medullary tissue being thereby exposed. This erosion sometimes appeared like a cross section of a number of plicæ on the same squamule, or of a series of superimposed squamules or lobes. It occurs sometimes in similar localities in the ordinary thallus of *P. saxatilis*, as well as on its anamorphoses. Frequently the medullary tissue exposed is of a brilliant saffron-yellow. I have frequently noticed on damp walls a similar condition of *Parmelia parietina*, giving the thallus and apothecia a white-variegated appearance.

The origin and mode of growth of the globular deformations of the thallus of *P. saxatilis* and *Cetraria glauca* above described, appear to me to throw a new light on the nature of the var. *concentrica* of *P. saxatilis* (Leight. 'Lich. Brit. exsicc.,' No. 232, fasc. 8, 1856), lately found by Sir W. C. Trevelyan, rolling freely before the wind on the exposed sheep-walks or chalk downs of Dorsetshire, and particularly on Melbury Hill, near Shaftesbury.* The characteristics of this curious lichen are, its erratic nature, its globular form, and its want of adhesion to any base of support. Its external appearance, as well as its characters on section, are very similar to those of the lead-coloured or grayish, globose anamorphoses of the thallus of *P. saxatilis* before referred to. Specimens of the latter, if detached and rolled about on the surface of the ground in a similar way, would undoubtedly acquire a similarly globose form. This erratic form of *P.*

* Proceedings of the Botan. Society of Edinburgh, in 'Scottish Gardener,' March, 1856, p. 100; and Notes by Rev. M. J. Berkeley, in 'Gardener's Chronicle,' Feb. 9th, 1856, p. 84, and March 15th, 1856, p. 172.

saxatilis appears to grow after detachment from its base of support; and its peculiar shape seems due both to curling up of the margins of the lobes, and to repeated and superimposed epithalline growths from and upon the original nucleus. The lobes or laciniæ are smooth, shining, and of a light gray tint. A few grayish soredia are occasionally scattered over the surface; but I have not noticed, in specimens kindly forwarded to me by Sir W. C. Trevelyan, nor in the specimen contained in Leighton's 'Lich. Brit. exsicc.,' any of the reproductive organs of the Abrothalli. I do not, however, regard the absence of the latter as at all a disproof of the lichen being developed in the way I have hinted; for I have already stated that it most closely resembles sterile forms of the deformations of *P. saxatilis* above described. It is perfectly possible, moreover, that laciniæ or squamules bearing the pycnides, spermogones, or even apothecia of the Abrothalli, have been covered over and concealed by subsequent epithalline growths. "There is no good reason why they should not fructify," says Berkeley in the 'Gardener's Chronicle,' March 15th, 1856, p. 172; but if the view just propounded of the nature and origin of these erratic masses be correct, we should never expect to find on them the normal apothecia of *P. saxatilis,* though we might have good grounds for anticipating the occasional occurrence of the pycnides or spermogones of the Abrothalli. The theories hitherto started to account for their peculiar form do not appear to me to be satisfactory, viz., that they have been formed round the droppings of sheep or rabbits, as nuclei, or that they have grown on the twigs of trees, whence they have been subsequently detached. Berkeley and Babington regard the erratic lichen in question as a form of *Parmelia cæsia,* or one of the "short-lobed forms of the *Parmelia stellaris* group;" but Sir W. Hooker, Sir W. C. Trevelyan, and Leighton consider it a form of *P. saxatilis,* and in this opinion, though I had at first some difficulty in deciding, I entirely concur. Further, there is a close resemblance between this erratic species and various Lecanoras of a globular form, and showing no point of adhesion, which have at various times been described by travellers as suddenly covering, like manna, large tracts of country in Asia, and as being eaten by cattle and by nomadic tribes of natives.* Such lichens are the *Lecanora esculenta* and *affinis* of Tartary and Persia. I have not been fortunate enough to see specimens of these interesting lichens; but I think it ex-

* *Vide* the author's 'Popular History of British Lichens' (Reeve, London, 1856), pp. 211 and 228.

tremely probable that they are not independent species, but merely malformations of some more familiar lichens. This idea, Berkeley mentions, has also occurred to Sir W. Hooker.

I. *A. Smithii*.—Of 71 sheets, containing about 250 specimens of *A. Smithii* and *A. oxysporus*, generally intermixed, the former species occurred in 54 cases, or about 76 per cent.; while the latter was found in 42 cases, or about 59 per cent. Of the two species, therefore, *A. Smithii* is the more abundant, though the preponderance is not very greatly in its favour. The young apothecia appear first to occur as spherical, blackish warts in the medullary tissue of the matrix (by which name I mean to designate the deformed portions of the thallus of *P. saxatilis*, and other lichens, on which the parasite occurs). Increasing gradually in size and colour, such an apothecial wart pushes its way to the surface, and perforates the cortical layer, either by a slow process, whereby the latter is thinned without fissuring, or rapidly, whereby more or less extensive radiate-fissuring is produced. In the former case the cortical border of the nascent apothecium is comparatively entire; in the latter it is irregularly broken by the stellate fissures, which, like the apothecium itself, generally appear black. After its evolution through the cortical layer, the apothecium swells, becoming globose; and its margins gradually overlap the cortical border. To the latter the margins are at first more or less closely appressed: sometimes they become agglutinated; at other times they remain, or become, with age, free. The latter condition seems to be assisted, if not produced, by a gradual contraction, as the apothecium becomes mature and old, of its base,—the hypothecial tissue. This process goes on till the apothecium falls away, leaving a saucer-shaped cavity or foveola, closely resembling, at a later stage of its development, or rather retrogression, the cyphellæ of the *Stictæ*. With age, such cavities or pits become more urceolate, and their edges better defined. The latter are frequently distinctly raised and dark coloured; while the cavity of the foveolæ may remain whitish, reddish, saffron-coloured, or it gradually assumes a brownish tint. These foveolæ are peculiar to *A. Smithii*, and are frequently seen on the old thallus, especially in Highland districts. I have never noticed them in *A. oxysporus*. When young and emergent, especially if deplanate, the apothecia of *A. Smithii* resemble somewhat the nascent apothecia of *A. oxysporus*; but a microscopic examination will at once detect the difference. In specimens of *A. Smithii* from the neighbour

hood of Portree, Skye, I found the young apothecia indistinguishable, by the naked eye, from those of *A. oxysporus*. These apothecia were flattened and black, with rough or pulverulent surface, agglutinated borders, and surrounding radiate-fissuring of the cortical layer of the thallus. The adhesion of the margins of the apothecia to the cortical layer is sometimes so intimate, that the base appears gradually shaded off or passing into the matrix, like the perithecia of *Verrucaria epidermidis*. This, however, is rare. I have seen it only in a few hill specimens. The gradual contraction of the hypothecium, or base of adhesion, renders the enucleation of the old apothecia easy.

Of the mode of evolution of the apothecia in his three species, Tulasne says that, in *A. Smithii*, "E matrice lente ac tali modo emergunt ut ejus cutem vix effringere illique e contrario primum marginibus adglutinari videantur;" in *A. Welwitzschii*, "Matricis cuticulam ita in erumpendo effringant ut istius frustula erecta hymenii discum quasi vallo ambiant;" while, in *A. microspermus*, "E matrice pedetentim emergit, cujus cuticulam fractam non sublevat et isti e contrario toto ambitu adnasci s. conglutinari diu videtur." The relations of the apothecial margins to the surrounding cortical tissue do not appear to me to furnish good characters for differentiation. I think I have seen all the appearances which Tulasne describes in different specimens of the varieties which I have designated *ater* and *pulverulentus*, even from the same locality. The *A. Welwitzschii* of Leighton's 'Lich. Brit. exsicc.' does not differ, either in external characters or in internal structure, from green-pulverulent forms of *A. Smithii* found by myself abundantly on Craigie Hill and elsewhere; but it rises directly from the ordinary thallus of *Sticta fuliginosa*. The only specimen which I have had an opportunity of examining has only two apothecia. One of these is flattened, not very prominent, and appears agglutinated at the margins; the other, on being moistened, becomes globose and substipitate, and has distinctly no raised margin of cortical tissue. Neither does the degree of flattening or convexity of the apothecia afford a good means of differential diagnosis; it differs widely in specimens from various localities. The apothecia of *A. Smithii*, says Tulasne, are "discoidea, pulviniformia, tandemque maxime convexa;" those of *A. Welwitzschii* are "magis vulgo deplanata;" while *A. microspermus*, "attamen puncta atra latiora et depressiora vulgo sistit." I have frequently met with the apothecia both of varieties α and β flattened, sometimes tuberculiform and even

confluent. In the latter case only two or three apothecia were usually in apposition; their margins, though modified by pressure, were distinct, and their surface was flattened. So flattened, semi-immersed, and inconspicuous have the apothecia of *A. Smithii* sometimes been in Highland specimens, that I have mistaken them, by the naked eye, for those of *A. oxysporus*. I have also seen them, in the old state, immediately prior to their falling out, when their base of adhesion is constricted to a very narrow peduncle, capitate or substipitate. The apothecia of var. *α* are sometimes exasperate or slightly black-pulverulent; or, still more rarely, in Highland specimens, they have appeared to be faintly marked by striæ or gyræ, like those of some of the Umbilicarias. Another basis whereon Tulasne founds his specific distinctions, is the presence or absence, as well as the degree, of green-pulverulence, of the apothecia. According to that observer, the apothecia of *A. Smithii* are "sparsim virenti-pulverulentis aut glabris;" those of *A. Welwitzschii* are "pulvere chlorino velatis;" while in regard to those of *A. microspermus*, he remarks, "nec pulverem virentem ei inspersum vidi." The green-pulverulence, I believe, is merely an illustration of the pulverulent or pruinose condition of the apothecia, so common among lichens, and which is one form of sorediiferous degeneration. The green powder, which varies greatly in degree, consists chiefly of gonidia; as do also the globose, greenish, powdery warts, resembling, in general appearance, the apothecia, in var. *β pulverulentus*, which I have met with occasionally on the same thallus,—as in specimens from Craig-y-Barns, Dunkeld. These warts are generally less regular in form than the apothecia in question, from which, however, they are sometimes indistinguishable without the microscope. I have repeatedly seen black and green-pulverulent apothecia occurring on the same thallus: but in certain localities the former predominate; in others the latter. On Ben Lawers I found only black apothecia; on Craigie Hill, Perth, the green-pulverulent ones are abundant. The latter I have noticed chiefly in damp, shady places—precisely the situations favorable to sorediiferous degeneration.

The development of the thecæ and spores resembles what obtains in the majority of other lichens. The theca arises from the hypothecium as a small, colourless, spherical cell, which gradually becomes elongated upwards so as to acquire a clavate form. It contains at first a colourless, minutely granular or amorphous protoplasm, which fills its whole cavity. Gradually this is limited by the spore-sac, which is

seen, especially under the use of iodine and other reagents, to be distinct from the thecal wall, more particularly at the apex, where a considerable space sometimes intervenes between them. The protoplasm slowly acquires a pale yellowish tint, and become smore granular; bye and bye it exhibits division into oval masses, which are the future spores. Two button-like nuclei of a pale lemon-yellow colour soon appear, and occupy those parts of the spore which are subsequently divided by a central septum into the two loculi. Meanwhile the theca has increased in breadth towards the apex, and has assumed more of an obovate form; the spore-sac and thecal wall have been distended by the gradual development of the spores. At this stage the theca is a very pretty object under the microscope. The protoplasm, as yet faintly coloured and finely granular, is studded over with the button-like nuclei of the spores, which are more prominent than their walls or septa. A similar appearance may be readily observed in the young thecæ of *Parmelia parietina* and some other lichens. This button-studded appearance, however, is much better marked in *A. oxysporus*, in which the spores remain colourless or very pale, and the lemon-coloured nuclei consequently very prominent; besides the spores of *A. Smithii* do not always possess or exhibit the nuclei in question. The septum of the spores now becomes apparent; their walls are better defined; their colour has passed through various shades of yellow and green till it has become an olive-green; and the nuclei or secondary cellules remain or disappear. The distension of the theca progresses in proportion to the maturescence of the spores, the inferior extremity or peduncle tapering suddenly or gradually from the upper, sometimes almost spherical, portion. Finally, the spore-sac and theca are ruptured at the apex, and, immediately after the emission of their contents, disappear. The spores escape, and after they are free they expand in dimensions, acquire more of a brown colour, and have a better-defined wall and septum; the loculi are separated by a distinct constriction, and they exhibit an inequality of size, one being considerably broader than the other. Tulasne speaks of the thecæ in the genus Abrothallus being clavate; but this appears to me to be true of them only in their young state. I have repeatedly tested the amyloid nature of the thecæ by solutions of iodine, diluted and strong, but with negative results. In one or two cases only did I discover a faint bluish tint developed; in the majority the iodine merely communicated its own tinge or produced no effect. This result accords essentially with the

observations of Tulasne, who says of the thecæ of *A. Smithii*, "In iode soluto immersi nonnisi apice et dilute, quandoque etiam vix conspicue cærulescunt:" of those of *A. Welwitzschii*, "nec nisi dilutissime in iode soluto cærulescunt:" while those of *A. microspermus* consist of a "membrana crassa qua fabricantur in iode soluto tantum sordide flavescit eodem scil. modo ac sporæ."

In all the varieties which I have examined the spores had essentially the same characters. As measured by an eye-piece micrometer, made by Bryson of Edinburgh, they generally varied in length from $\frac{1}{1100}$ to $\frac{1}{1500}$ inch, and in breadth from $\frac{1}{2500}$ to $\frac{1}{3500}$: sometimes, however, they were larger; at other times smaller. In general appearance they resembled the spores of *Physcia ciliaris*, and some of the *Calicia;* and they appeared intermediate in size between them. Körber describes them as shoe-sole-shaped ("schuhsohlenförmig"), which, though rather an awkward designation, conveys a very true idea of their appearance. In many cases there was little distinction in size between the loculi: these were chiefly young spores. The spores were generally olive-green—seldom of a deep brown. The latter tint I have observed only in a few instances—as in specimens of var. *α* from Ben Lawers, the *A. Welwitzschii* of Leighton's 'Lich. Brit. exsicc.' &c., The spores of the Ben Lawers specimens were dark umber-coloured, and broader than any I have as yet seen: they had somewhat the appearance of a figure of 8, and closely resembled on a small scale the spores of *P. ciliaris*. Tulasne describes the spores of *A. Smithii* as "atræ v. spisse fuscæ;" those of *A. Welwitzschii* as "saturate fuscæ;" and those of *A. microspermus* as "vulgo pallidæ." I would suggest that the dark colour of the spores observed by him may be due to his having examined chiefly herbarium specimens. Iodine seems to have no reaction on the spores of *A. Smithii* or *A. oxysporus*. Tulasne allows a similarity in the characters of the spores between his *A. Smithii* and *A. Welwitzschii;* for he says of the latter, "ab illis ejusdem lichenis forma crassitudineque non differunt." Of *A. microspermus*, he remarks: "Speciei criterium in seminum utriusque generis exiguitate præsertim ponitur." The paleness and minute size of the spores here constitute a peculiarity; but they do not appear sufficient to form specific differential characters. Körber remarks: "Die Unterschiede von der vorigen Art (*A. Smithii*) sind nur gering, so dass sie vielleicht besser als Varietät zu dieser zu bringen ist" (p. 216). Tulasne gives, as the habitat of this species, *Parmelia caperata.* Körber says *P. caperata* with *A. micro-*

spermus parasitic on it is rare in Germany. I have had no opportunity of examining it. When its minute anatomy is fully investigated, good grounds may appear for retaining it as an independent species; meanwhile I cannot give it a higher place than that of a variety. Tulasne himself confesses, "Abrothallum Smithii et hunc præsertim qui in Parmelia tiliacea parasitatur summopere æmulatur."

In *A. Smithii* "Guttula oleosa in utroque cujusvis sporæ maturæ locello includitur," says Tulasne. In certain cases I have noticed secondary cellules or nuclei in the spores: in others I have not. They were distinct in specimens from Craig-y-Barns, Dunkeld: they were absent in *A. Welwitzschii,* from Torquay, and in *A. Smithii,* from the Wrekin, Shropshire (both contained in Leighton's 'Lich. Brit. exsicc.') Frequently one comparatively large cellule occurred in each loculus, lying usually towards the outer extremity thereof: sometimes there were two in each, their size being smaller; or one of the loculi contained a large nucleus, while the other contained two smaller ones. In apothecia from certain localities, or on particular thalli, this character of the spores was pretty constant; but the nuclei in question were as frequently, in other specimens, absent. I could not satisfy myself as to the oily nature of these bodies; they appeared to me to be too regular in their form, too uniform in their position, too constant in certain specimens, while they were altogether absent in others, to be mere "guttula oleosa." The use of ether, aqua potassæ, aqua ammoniæ, and other reagents, has satisfied me of the oily nature of the globules and protoplasm of the stylospores, and also of a portion, at least, of the protoplasm of the spores of *A. oxysporus.* But I have been unable to convince myself that the nuclei of the latter, or of the spores of *A. Smithii,* are solely or partially oily. Another difficulty frequently occurs in regard to determining the nature of the nuclei of certain spores. The characteristic yellow nuclei of the spores of *Parmelia parietina,* for example, have been variously regarded as an external coating of the ends of the spore, as secondary cellules occupying the opposite extremities of the interior of a cell, having thin walls, or as vacuoles hollowed in the material of a thick-walled or solid spore, and full of an oily or other protoplasm. It seems probable that spores and nuclei, possessing these varied characters, really do exist, though, in particular instances, it is difficult to decide to which of the classes above mentioned to refer them. In the spores of the Abrothalli the nuclei—be they cellules or globules—appear to occupy the interior

of a free cavity. On the same apothecia I have sometimes found the spores of both species of Abrothallus, as well as stylospores; and, on the thallus, the spores of various Lecideas and other lichens may also be met with. This illustrates the dissemination of the spores of lichens by the winds, rains, and other agencies.

So far as my observations enable me to decide, this species possesses no spermogones of the ordinary type—that is, of the structure usual in those of most lichens. I shall presently show that I am inclined to regard the pycnides as another or extraordinary type of spermogones,—in certain exceptional cases taking their place and fulfilling their functions. *A. Smithii* and *A. oxysporus* are frequently so intimately associated that the one may appear to possess spermogones and the other pycnides. In a few cases, I have seen spermogones intermixed with, and apparently belonging to, *A. Smithii;* and pycnides scattered among, as if pertaining to, a young state of *A. oxysporus;* but in the former case they really belonged to *A. oxysporus,* and in the latter to *A. Smithii,* the apothecia of which were also interspersed.

Of fifty-four sheets of specimens of *A. Smithii* (generally associated with *A. oxysporus,* and growing on furfuraceous states of *P. saxatilis*), I found *pycnides* present in thirty-four cases, or about 63 per cent.; while in forty-two sheets of *A. oxysporus* (similarly growing, and with which *A. Smithii* was associated), *Spermogones* occurred only in five instances, or about 12 per cent. The pycnides were therefore upwards of five times more frequent in *A. Smithii,* than the spermogones in *A. oxysporus.* Hence the normal, or usual, type of spermogones is comparatively rare in the genus Abrothallus; while the pycnidian, or exceptional, type is somewhat common. This is one of the characteristic features of the genus. In twenty-seven of the thirty-four cases, in which pycnides occurred, they were associated with the apothecia of *A. Smithii;* in four cases they were found alone, chiefly on the bluish or lead-coloured squamules already described; and in three instances they were intermixed with young apothecia of *A. oxysporus,* to which species they appeared (but erroneously) to belong. In site and external appearances, the *pycnides* closely resemble the spermogones of *A. oxysporus,* hereafter to be described; and are extremely apt to be mistaken therefor or confounded therewith. Like the latter, they occur as minute, black points, scattered generally over the surface, or only towards the periphery, of the squamules or lobes. Each point or spot is perforated by a simple or stellate pore, whose edges may be flattened, raised,

or occasionally depressed. This ostiole is, however, generally larger and more prominent than that of the spermogones, and its edges more frequently swollen and raised. Sometimes—as in specimens of *A. Smithii* from Glen Shee and Glen Beg—the pycnides are superficial, and prominent, forming rough, tuberculated, black warts, seated on the surface of the thallus, each pierced by a distinct pore. The body of the pycnidis is immersed, spherical, and enclosed in a brown cellular tissue. When moistened, the pycnides appear as brown translucent spots, precisely like the spermogones. Tulasne says that the pycnides of *A. Smithii* are "interdum copiosissimæ, imo apotheciis multo frequentiores," especially when they occur on *Parmelia tiliacea;* he also describes those of *A. microspermus* as abundant; but of *A. Welwitzschii,* he remarks, "Pycnides desiderantur." I have found the pycnides indiscriminately associated with varieties α and β, and am convinced that the description of the pycnides of his species *A. Smithii* applies equally to those of his *A. Welwitzschii.* I have never, however, noticed pycnides so abundantly distributed as Tulasne would seem to imply. I have seen an intermixture of spermogones with young apothecia in *A. oxysporus,* associated on the same squamule with *A. Smithii,* "interdum copiosissimæ;" and it appears to me possible, from the great resemblance, that Tulasne may have hurriedly overlooked the distinction between them, more particularly as he speaks of the "spermogoniæ ignotæ" of the genus Abrothallus. I have most frequently found the best specimens of pycnides scattered, to the number of four or six, near the margin of sterile squamules, which had a leaden or grayish hue, and were thickened, corrugated, and warted. While the other characters are similar, the pycnides differ remarkably from the spermogones in containing *stylospores,* instead of spermatia. These are cellular bodies, having much the appearance of certain spores, about $\frac{1}{1500}$ to $\frac{1}{2300}$ inch long, by $\frac{1}{2500}$ to $\frac{1}{3000}$ broad. They are normally pyriform or obovate; but they are sometimes spherical, oval, oblong, navicular, fusiform, or present irregular bulgings. These abnormalities of form generally occur in Highland specimens. Viewed in different lights, they may be colourless or of a pale yellow tinge; sometimes the contained globules were pale yellow; at other times the whole stylospore was of a distinct yellow. In the latter case, in Highland specimens, the stylospores were generally small and shrivelled. With regard to their contents, Tulasne remarks, "Nunc protoplasma subliquidum fereque homogeneum, nunc guttulas oleosas 2—3 fovent,"

in *A. Smithii*; while in *A. microspermus*, they are "mate-rieque oleosa et homogenea fœtas." All these conditions frequently exist in the stylospores of the same variety. Very frequently a single large globule occupied the cavity of the stylospore, extending across its whole breadth, but leaving interspaces at the extremities; or a large globule filled the broader end, while the opposite contained two or more smaller globules. Sometimes the stylospore contained a mass of small globules and granules of different size; at other times the protoplasm was finely granular or grumous; or it was perfectly homogeneous and transparent. This appeared to be the highest state of development of the stylospore. The application of ether, aqua potassæ, and aqua ammoniæ satisfied me that in all these cases the protoplasm was oily. The oil globules could readily be squeezed from the stylospores, and made to coalesce into larger globules; and the stylospores were almost invariably associated—sometimes to a marked extent—with free, floating oil globules. Under the reagents these free oil globules were greatly increased in number and size, and the globules contained in the stylospores could be seen gradually being dissolved or broken up into a homogeneous fluid. These globules, like other oil globules, refracted light powerfully, and were very prominent objects in the interior of the stylospores. Their numbers and size differed greatly in specimens from various localities. They were very large and numerous in Ben Lawers specimens, in which the stylospores were associated with a large quantity of free oil globules. A similarly large intermixture of oil globules, especially in the young state of the stylospores, was also observed in specimens from Glen Shee, the vicinity of Dumfries, and other localities. Some of the stylospores, in specimens from Ben Lawers, bore a resemblance to certain cellular spores, especially when elongated and containing two or more large globular nuclei. Here also there was considerable deformity of shape; some of the stylospores, which were among the largest I have seen, were almost spherical in form, and might have been mistaken for empty gonidia. This was not unfrequently the case also in other specimens. I have occasionally—as in specimens of *A. Smithii* from Glen Shee—seen the stylospores, from their shape and the arrangement of the contained globules, resembling certain states of the spores of *A. oxysporus*. Of the colour of the stylospores Tulasne says, "Singulatim spectata dilute flavida diceres;" while "horumce corpusculorum congeries in pycnidis sinu albescit copiosumque admittit aerem." He remarks further,

"Iode protoplasma fucatur, membrana autem utriculi vix mutatur." I did not find iodine produce any change further than communicating its own tinge. Like the spermatia, the stylospores are borne on a series of sterigmata, closely crowded together, and arranged in relation to the walls and cavity of the pycnidis as the spermatial sterigmata are to those of the spermogone. But the filaments generating the stylospores are uniformly simple and one-spored—the stylospore invariably being thrown off from the apex, and never from the sides. These filaments vary greatly in length; generally they are very short or inconspicuous; sometimes they appear to be absent. There is considerable variety also in thickness; being sometimes thick and short, at other times long, slender, and thin. In both cases they are usually very delicate. Sometimes they become shrivelled, and are retained, as caudate appendages, by the stylospores; this I frequently observed in the small yellow stylospores in Highland specimens. Each sterigma would appear to generate—as do also the spermatial sterigmata—a continuous series of stylospores, which in this case are thrown off as terminal cells or buds. The sterigmata of *A. Smithii*, Tulasne describes as "brevissimis stipatissis quandoque vix conspicuis crassis ac monosporis;" while, in *A. microspermus*, they are inconspicuous and but rarely "linearibus et longiusculis." The stylospore first appears as the rounded, bulging, or obovate extremity of a short, simple filament, which resembles, except in length, the paraphysis of a lichen. The end of this filament is full of a finely granular matter, which accumulates especially in the bulging portion; the latter is gradually separated by a septum. The terminal cell becomes broader towards its free end, and narrower towards its insertion upon the sterigma, until, at length, it is thrown off as the stylospore. The latter appears to attain its full size only after it is free; it expands in all its dimensions and acquires a pyriform shape. The granular protoplasm now becomes more distinct and more coarse; there is a gradual fusion of the smaller granules into globules, and these into larger globules, until the cavity of the stylospore is occupied by one or more large globules as I have already described. Finally these appear to deliquesce into a homogeneous, colourless, oily fluid, which gives rise to the colourless pyriform stylospore with apparent double contour. I have seen nothing like germination in the stylospores.

Stylospores have been hitherto found only in another minute parasitic genus—also described recently by Tulasne in his admirable memoir on the organography and physiology of the

lichens—*Scutula*. Their relation to the function of reproduction has yet to be determined. In certain respects they bear an analogy to the spermatia; in certain other respects to true spores. They are generated in conceptacles closely resembling, in site and external form, the spermogones; they also appear to precede the spores in order of development, and to be rather cotemporaneous with the spermatia; they are moreover, extra-thecal or extra-cellular, and are thrown off from the apices of peculiar filaments or sterigmata. On the other hand their size and form, and the nature of their contents, approximate them more to the character of true spores. There is a remarkable resemblance, however, between the stylospores and the pyriform or obovate bodies described as the spermatia of the Peltigeræ by Tulasne ('Mém.,' p. 200). The section of a spermogone of Peltigera precisely resembles, in the form and arrangement of its sterigmata and spermatia, the pycnidis of Abrothallus. A careful investigation will demonstrate that there is a regular gradation, in form and size, between the ordinary, straight, rod-shaped, minute spermatia of *Parmelia parietina*, *P. physodes*, or *Physcia ciliaris;* the ovoid spermatia of *Lichina confinis* and *L. pygmæa*, or of *Urceolaria calcarea* and *U. scruposa;* and the pyriform, comparatively large spermatia of *Peltigera canina*. From the anatomy of the genus Abrothallus,—which alone, however, is not sufficient to decide a question of such importance,—I am strongly inclined to regard the pycnides as merely an unusual form of spermogones, and hence undeserving of a separate designation and consideration. In *A. Smithii*, I have already stated I have never observed spermogones; and in *A. oxysporus* I have not met with pycnides. But the pycnides appear to bear precisely the same relation —in regard to site, predevelopment to the apothecia, &c.,— to the former, that the spermogones do to the latter. They are, therefore, probably endowed with similar functions, and act as substitutes for each other. Körber also regards the pycnides as the analogues of spermogones, for he says: "Ich halte dieselben für Analoga der Spermogonien, die, in der gewöhnlichen Form, bei Abrothallus zu fehlen scheinen, wobei freilich die bedeutendere Grösse der Stylosporen vor derder spermatien der übrigen Flechten sehr auffallig ist" (p. 215). Prior to the elaborate researches of Tulasne and other careful observers, the pycnides would undoubtedly have been regarded as the reproductive organs of some parasitic fungus. But we now know that some of the more minute fungi possess so many as four or five different kinds of reproductive bodies; and from the close affinity between the

lower tribes of fungi and lichens, there is good ground for believing that a similar diversity may occur also in the latter. Tulasne, who is no less eminent as a mycologist than as a lichenologist, regards the pycnides, which I have described, as properly pertaining to the genus Abrothallus; and Berkeley, than whom there is no more competent authority in this country, holds a similar opinion. In a recent correspondence with the latter distinguished botanist, he informs me that he is acquainted with one fungus—*Erysiphe* (*Ascomycetes*, subord. *Perisporiacei* of Lindley's 'Veget. Kingdom,' 3d. ed., 1853, p. 43)—which has no less than five different forms of reproductive bodies or organs, none of which can be looked upon as spermatia according to Tulasne's views; that many species of *Diplodia*, *Sphæropsis*, *Phoma*, &c., belong to *Sphæria*, *Tympanis*, *Cœnangium*, &c.; and that, prior to the recent discoveries on the reproduction of lichens, the pycnidis of the Abrothallus would have been designated a *Phoma*. The fact that the lower fungi and lichens may possess several very different reproductive corpuscles must greatly modify our future views of classification and nomenclature. "So convinced am I," says Berkeley, "of the near relation of lichens to fungi that, in the portion of my introduction to 'Cryptogamic Botany' which is printed, I make one division, *Mycetales*, to include *Fungales* and *Lichenales*" (*in lit.*)

I have occasionally noticed in the tissues forming or surrounding the walls of the pycnides, peculiar tubes, presenting, at irregular intervals, bulgings, which ultimately, by elongation and expansion, become dilated into obovate cells, destined to be thrown off like buds or gemmæ. In these lateral dilatations the granular protoplasm of the parent tubes appeared to accumulate, a septum was gradually developed, and the gemmule fell off at the point of division. These tubes generated large numbers of such cellular bodies, which increased in dimensions after their separation, and frequently bore a close resemblance to the stylospores, except that they were generally less regularly pyriform. Similar structures I have also noticed in the tissues of other lichens; but I have not yet directed special attention to their nature, and can, therefore, throw no light on the part which they play (if any) in the function of reproduction. The spermatial sterigmata in *A. oxysporus* appear sometimes to be developed laterally from tubes in a similar way. I have also observed in the tissues of various lichens, a tendency in certain filaments to develop lateral and terminal cells, of a round or obovate form, varying greatly in size, and generally

more or less granular internally. Similar appearances are figured in the elaborate but highly speculative memoir of Bayrhoffer.* I mention these crude observations suggestively here, not only from a wish to show that the reproduction of the lichens is even yet imperfectly understood, and that the subject of these accessory or secondary reproductive corpuscles will amply repay elaborate research, but because I am desirous of entering my protest against exceptions taken by Tulasne to certain observations made by Berkeley and Broome, Dr. J. D. Hooker and Babington, in this country. From some, apparently casual, observations of these botanists, it would appear that the paraphyses may sometimes assume the function of sterigmata, generating from their apices spheroid corpuscles, or may themselves be transformed into reproductive bodies. Tulasne throws a distinct doubt on the accuracy of the observations in question ('Mem.,' pp. 110 and 111), and endeavours to explain them as the result of an optical error. He remarks, and with great truth, that the spores of certain species, from their tenuity and other characters, closely resemble the paraphyses (*e. g.* among the Peltigereæ); that after emission from the theca they sometimes become entangled among the paraphyses, and may there germinate; and that in such a case true spores might *appear* to be generated *by*, instead of only *among*, the paraphyses. I have never seen the phenomena described by Berkeley and Babington, and therefore cannot vouch for the accuracy of their observations. But I have seen the terminal cells of the paraphyses, especially under the use of reagents, remarkably resembling gonidia or stylospores, or the cellules which I have described as generated, laterally and terminally, from peculiar tubes. Under the use of aqua potassæ, for example, I have seen the tips of the paraphyses of the apothecia of *A. Smithii* dissociated, the brown colouring matter dissolved out, and the obovate terminal cell occupied by a colourless globule or globules, giving it precisely the appearance of many of the stylospores of the same species. So long as we are ignorant of the origin, development, and functions of the corpuscles which I have mentioned, and while there is reason to believe

* 'Einiges über Lichenen und deren Befruchtung.' Bern, 1851.

Compare pl. i, figs. 11 and 12. "Einzelne fasern mit an den Enden und Seiten befindlichen runden Zellchen." Figs. 13 to 15. "Fasern mit Zellen der männlichen Gonidien-zellen."

Pl. ii, figs. 7 to 11. "Männliche Prosphysen—mit runden Endzellen"—"mit eiförmigen Verlängerungen"—"mit walzenförmigen Verlängerungen (abgeschnüret die Androsporen und noch einigen runden Zellchen)." Figs. 17 to 20. "Weibliche Prosphysen in verschiedenen Entwickelungs-stufen."

Pl. iii, fig. 12 *a*. "Losgelöste Prosphysen."

that we shall ultimately find the means of multiplication in the lichens wonderfully varied, and not at all in accordance with our preconceived notions, I consider it hazardous and improper to doubt or depreciate the observations of any botanist, and especially of men of such scientific eminence as the gentlemen whose names I have enumerated.

II. *A. oxysporus*.—I have already given so many details regarding the structure of *A. oxysporus*, in contrasting it with *A. Smithii*, that little now remains for me to add. Körber says, "Die übrigen Abrothallus-Arten [besides *A. Smithii* and *A. microsp.*] welche Tulasne noch unterscheidet, aber in Deutschland bisher noch nicht beobachtet zu sein scheinen, gehören, nach ihrem Sporencharacter, *nicht* in diese Gattung" (p. 216).

I cannot regard the mere character of the spore to be a sufficient reason for constituting species; else we should split up the lichens into an endless number. *A. Smithii* and *A. oxysporus* occur so constantly and intimately associated, the mode of evolution and growth of the apothecia in both is so precisely alike, and their apothecia are frequently so similar in external appearance, that I must look upon them as pertaining to one genus. The pycnides of the one, and the spermogones of the other, also serve to distinguish them; but I think only as species. I cannot here omit a protest against the unnecessarily and mischievously elaborate classification of Körber, who, in his last publication, enumerates in Germany 136 genera, while I feel assured less than one third would be found amply sufficient. It is this splitting up of species and genera; this multiplication of new and difficult names; this complete changing of old familiar terms, that operate as one of the most powerful barriers to the study of lichenology. It is only, I am convinced, by simplifying the science—by making genera and species as extensive as possible and thus diminishing names—by merging special peculiarities in general laws, that we can hope to make lichenology attractive. As a general rule, whenever *A. Smithii* occurs, *A. oxysporus* may be looked for. In the majority of cases, I found them growing together on the same thallus; under which circumstances it is very difficult to determine to which species to refer the spermogones and pycnides generally more or less plentifully intermixed. On Craigie Hill, I met with both species abundantly. In other localities the one or other predominated—*e. g. A. oxysporus* on Moncrieffe Hill, and *A. Smithii* on Ben Lawers. The geographical distribution of the Abrothalli seems very irregular, and is controlled by circumstances with which we are not

yet fully acquainted. I have never found them on the ordinary thallus of the common *Parmelia saxatilis* (the var. *leucochroa* of Schærer's 'Enum. Crit.'); and I have looked for them in vain on furfuraceous states in a variety of localities. Mr. Leighton mentioned to me recently (*in lit.*) that he has never found Abrothalli in Shropshire, though he has frequently looked for them; and that in Wales they are by no means plentiful. It is very desirable that collectors should direct attention to this subject.

The apothecia first appear about the centre of a squamule, where also the oldest and most fully developed specimens are to be found. The thalli on which *A. oxysporus* occurs are more frequently simple or polyphyllous squamules, and tend less to become globose and hypertrophic than those habited by *A. Smithii.* The young apothecia are punctiform, black, and scattered: they are frequently very similar to the spermogones, from which they can only be distinguished by the absence of an ostiole, and by microscopical examination. In the process of evolution, they more frequently fissure the cortical layer than those of *A. Smithii*; the surface of a squamule is sometimes marked by a network of these fissures, which run into, or anastomose with, each other. In the old state the apothecia sometimes become tuberculiform or maculiform; their surface is seldom raised much above the level of the surrounding cortical tissue, unless when moisture is applied. In the latter case the apothecium swells, the surface becoming more or less raised or convex. Moisture generally also changes its colour from a black to a light brown, but not invariably. The moistened, brown, swollen apothecium sometimes appears as if it were a discoid mass of gelatinous consistence. I have occasionally observed the apothecia depressed or saccate, as in specimens from the Highland road between Blairgowrie and Spittal of Glenshee. Tulasne says the apothecia are "punctiformia s. potius discoidea;" the former character appears to apply, however, only to young and undeveloped specimens, and not to normal mature apothecia. Besides the different effects of moisture on the apothecia of *A. Smithii* and *A. oxysporus,* the former remaining black, the section shows a deeper colour in the former than in the latter—black to the naked eye, but brown under the microscope. I have frequently observed sections of the apothecia of *A. Smithii* of a purple tint; while those of *A. oxysporus* have been invariably light brown. Besides the spermogones, the young apothecia are apt to be confounded with the pycnides of *A. Smithii,* and with certain parasitic fungi, which I have occasionally found interspersed; but these,

though bearing a close resemblance, to the naked eye, are generally more superficial, and their microscopic structure is quite different. I have, on several occasions, mistaken, by the naked eye, small, black, point-like parasitic fungi for the apothecia both of *A. Smithii* and *A. oxysporus*, among which they were interspersed; most frequently for the latter. I have also sometimes found them growing on these apothecia,—as in specimens from Glen Dee, Braemar, where they inhabit those of *A. Smithii*. They are generally, however, much more irregular in shape, being usually more or less rough, tuberculated, and flattened. On microscopical examination, they are found to consist of a cellular envelope of a more or less deep brown tint, enclosing myriads of very minute, globular brown spores. I have already stated that the apothecia of *A. oxysporus* may be saccate. On the other hand, they are sometimes so prominent and convex,—as in specimens from Loch Coruisk, Skye, that I have mistaken them for young deplanate apothecia of *A. Smithii*.

The thecæ, says Tulasne, "subito deorsum acutatæ et cuneiformes factæ." This is, however, only one phase of their existence, due to distension of the spore-sac and theca, with the maturescent spores,—the lower part, or pedicle, as I have already explained, sometimes tapering suddenly from the upper, which bulges into a sphere or obovate vesicle. The theca consists, the same observer continues, of a "membrana qua struuntur, crassissima et achroa, quum iode soluto roratur statim tota amœne spisseque cærulescit, talique modo tincta diu (scil. 20 horas et quod excedit) consistit." In regard to the amyloid reaction with iodine, the thecæ of this species contrast strongly with those of *A. Smithii*. I uniformly obtained a blue colour, which was generally best marked in young thecæ, and at the apex, where the membrane is thickest. In some cases the hypothecial tissue, and, in others, the intercellular substance, which glues together the tips of the paraphyses, appeared to strike a blue colour with iodine, especially during the young state of the thecæ. Tulasne refers to this circumstance in regard to the paraphyses: "Materie amorpha cujus ope adglutinari videntur abundat cæruleoque colore in iode confestim inficitur." I am not certain, notwithstanding, that this amyloid matter does not really pertain to the thecæ. The tips of the paraphyses are of a much lighter brown than those of *A. Smithii*; the colouring matter appears here also more diffused. Their apices are so closely united, that it is generally impossible, without the assistance of reagents, to discover the outlines or characters of the individual terminal cells. But aqua potassæ at once causes their

dissociation, and dissolves out the colouring matter, rendering distinct the terminal cell and its septum. In some cases a delicate colourless membrane appears to overlie and connect the apices of the paraphyses, but is really probably a thin layer of the mucilage or intercellular substance already referred to.

The spores are usually about $\frac{1}{1100}$ to $\frac{1}{1200}$ inch long by $\frac{1}{3000}$ to $\frac{1}{4000}$ broad; they are rather longer than those of *A. Smithii*, but about equal in breadth. They vary greatly both in size and form. Normally, they are ellipsoid, with acute extremities; colourless or pale yellow, having a double contour, and usually a lemon-coloured globular nucleus, arranged in the central axis, at either end. But they are sometimes lanceolate, fusiform, or caudate; or they are short and broad, swelling nearly into an ovoid or spheroid. In the latter case there is sometimes only one nucleus; or, if two, they are eccentric. In some cases the spores are empty, or full apparently of a homogeneous, colourless, oily fluid, resembling in this respect many of the stylospores; or they are filled with globules and granules of different size. The latter condition occurs in an abortive form or a permanently undeveloped type; and also in the old state, in which the nuclei become broken up into globules and granules. In certain states, when devoid of nuclei, the spores bear a resemblance to those of some Peltigeras and Stictas. Like the spores of *A. Smithii*, they appear to be arranged in the thecæ in a spiral manner. Their nuclei are much more constant in their occurrence than those of the spores in *A. Smithii;* they occupy those portions of the spore which, in the latter species, become the loculi. They germinate like many other spores, sending out a delicate filament from one extremity. They are, says Tulasne, "nucleo inæquali heterogeneo vixque (saltem de specie) oleoso gravidæ, in sinu cujuslibet asci inordinate generantur." I do not fully comprehend this description. The intra-thecal development of the spores I have already described when referring to those of *A. Smithii*.

The *spermogones* I have seen more or less abundantly in specimens growing on *P. saxatilis*, from Craigie Hill, Perth; Birnam Hill, Dunkeld; various parts of the Highland road between Blairgowrie and Braemar; various localities round Braemar; Ben Nevis; Barmouth, Wales, and other localities; and also on *Cetraria glauca* and *P. conspersa* from the latter locality. They occur as extremely minute, black, point-like bodies on the surface of the thallus, scarcely discernible by the naked eye. With the aid of a good lens, each of the point-like spots is found perforated in its centre

by a simple or stellate ostiole or pore, with flat, more frequently raised, and sometimes, but rarely, depressed borders. Even under the lens, and especially in young spermogones, the pore is often imperceptible. It may be made more prominent by moistening the spermogone, whose tissue is very hygrometric, swelling rapidly and greatly in water; the ostiole becomes thus more patent, and its edges better defined. With age also the ostiole becomes more open and generally stellate, the cavity of the spermogone being empty and its walls hardened. In old spermogones also the depressed or saccate character of the ostiole is occasionally observed. The ostiole leads into a somewhat spherical and simple cavity, whose envelope consists of a brown cellular tissue, and whose internal walls are lined by a compact series of sterigmata,—arranged perpendicularly to the spermogonal walls, and convergently to the centre of the spermogonal cavity,—generating from their apices myriads of spermatia. When moistened, the spermogones assume a light brown tint; and when the thallus or matrix is moistened and viewed by transmitted light, they constitute a series of brownish, translucent, round spots, amid the surrounding dull opaque green (of the gonidic layer shining through the brownish cortical tissue). The sterigmata are simple, cylindrical, or almost linear cells, frequently very irregular in form, being sinuous in their outline, and presenting bulgings or bendings. On tracing carefully their connection with the walls of the spermogone, they appeared to me to be given off as a series of hollow buds, at irregular intervals, from a peculiar tubular tissue. The wall of the parent-tube presented a bulging which became dilated and elongated into the form of a sterigma. From the apex of the latter a smaller bud was developed, which became elongated into a linear, very slender, straight rod-shaped body; on attaining a certain length, a septum became visible at the point of junction between this body, the spermatium, and its sterigma, and a severance took place. The sterigmata often came off in groups from the parent-tubes, and, when elongated and narrow, not unfrequently resembled the fingers of the hand. Sometimes the sterigmata were nearly as narrow as their spermatia, into which they gradually tapered. The spermatia were either seated perpendicularly on the apices of the sterigmata, or they came off at various angles, which were occasionally very acute. In the latter case there was frequently a bulging or dilatation of the sterigmata immediately before they gave off the spermatia.

The *spermatia* between about $\frac{1}{4000}$ and $\frac{1}{5000}$ inch long. I

had abundant opportunities of observing the peculiar, wriggling, swimming, and diving motion which has attracted the attention of so many lichenologists, and given origin to so many ingenious theories as to its nature. But I see no reason to doubt for a moment that it is merely the molecular or Brownian motion now so familiar to botanists. The movements occur only in free, isolated, floating spermatia; *en masse* they are at perfect rest. Iodine had no effect on the spermatia or sterigmata further than communicating its own tinge; but the network of tubes from which the latter spring, or the intercellular matter, appeared sometimes to assume a bluish colour.

It may be advisable here to point out the resemblances and differences between the spermogones of the Abrothallus and those of *P. saxatilis*. I have examined the spermogones of *P. saxatilis* on various furfuraceous forms from Norway, Ben Lomond, the Kyles of Bute, and other localities. In external characters they closely resemble those of the Abrothallus. They occur as extremely minute, black points scattered over the surface and towards the extremities of smooth laciniæ. Each spot is perforated by an almost imperceptible ostiole—simple or stellate—which leads into the spermogonal cavity. The sterigmata which line its walls, however, are very different from those of the Abrothallus. Here they are equally delicate and narrow; but they are articulated, ramose, and much longer. There is, however, a great want of uniformity in length, some of them projecting far beyond the others. The articulations consist of simple, cylindrical cells, generally joined to each other at more or less irregular angles. Spermatia are given off perpendicularly, or at various angles from the apex of each articulation; consequently the sterigmata generate spermatia both from their apices and sides. The latter, indeed, appear to come off from the former as a series of minute lateral branches or buds. The spermatia are very abundant; they are about the same length as those of the Abrothallus, but they frequently appear more slender. Körber describes "Spermogonien auf den Runzeln des Lagers als schwarze gehäufte Wärzchen bisweilen wahrnehmbar, mit sehr kleinen, *fast kugligen* [?] Spermatien" (p. 73). In addition to the sterigmata there arises from the walls of the spermogone a series of very delicate ramose filaments, which project far beyond them, and fill its cavity with a delicate network formed by their anastomoses and ramifications. These filaments are sterile. Sometimes they are articulated or septate at the extremities, which may appear proliferous; but this is pro-

bably an illusory appearance due to adhesion of some of the abundant floating, free spermatia. These filaments generally terminate in a rounded bulging extremity, the interior of which contains a more or less finely granular material. From their abundance, growing as they do from among the sterigmata, they are apt to conceal the latter. They occur also in the spermogones of several other lichens—such as *Parmelia physodes*, and some of the *Ramalineæ* and *Umbilicariæ*. The nature and function of these peculiar filaments have not hitherto been determined. Possibly they are abortive and hypertrophied sterigmata; or their terminal cells are thrown off as accessory reproductive bodies of a kind with which we are as yet unacquainted. Further researches of course are necessary to settle this point.

In specimens of *A. oxysporus*, growing on *P. conspersa*, the spermogones of the Abrothallus and Parmelia are apt to be confounded. One of the most prominent characters of *P. conspersa* is its black-punctate thallus; hence, indeed, its very appropriate name. The minute black points, so abundantly scattered over its surface, are the spermogones. These thalline spots are each perforated by an ostiole which leads into the cavity of an immersed, spherical, one-locular spermogone. Here, however, as in the analogous case of *P. saxatilis*, the resemblance ceases; for the sterigmata and spermatia are much more delicate or slender, and the former are articulated, each joint being a narrow linear cell. Its spermogones are frequently also dotted over the outer surface of the thalline exciple of the apothecia, and also on the hypothecium, after the falling out or erosion of the hymenium or lamina proligera. The falling out of the latter leaves a saucer- or cup-shaped organ of similar colour to the thallus.

In searching for spermatia, it is necessary to bear in mind that the spermogones precede, in order of development, the apothecia; and that, by the time the latter have attained maturity, the former have been long since emptied of their contents. Young spermogones containing spermatia should, therefore, be looked for on young or sterile thalli or lobes, or on those bearing only nascent apothecia. I have found the spermogones in best condition on portions of thallus destitute of apothecia. The same remark may be applied to the pycnides of *A. Smithii*. Though strong grounds exist for regarding the spermatia as fertilizing or impregnating corpuscles, the process of impregnation has not been hitherto detected in lichens. It still remains a problem for microscopists. The discovery of spermogones in lichens has already

made, and is destined still further to create, great changes in our knowledge of the structure and classification of the more minute lichens. It has been lately determined that the genus *Pyrenothea* constitutes the spermogones of various more familiar lichens,—*e. g.*, *P. leucocephala*, Fr., consists of the spermogones of *Lecidea abietina*, Ach., and *P. vermicellifera*, Kunz, of those of *Biatora luteola*, Fr.

"Pycnodites nondum innoturunt," remarks Tulasne tersely. This statement my own experience—as I have already mentioned in describing the pycnides of *A. Smithii*—enables me to corroborate.

The existence of Birds *during the deposition of the* Stonesfield Slate *proved by a comparison of the* Microscopic Structure *of certain* Bones *of that formation with that of* Recent Bones. By the Rev. J. B. P. Dennis, F.G.S., Bury St. Edmunds.

From extensive observations made upon the bones of birds, I find that, in their microscopic characters, their bones are as distinct from those of mammifers as the latter are from the bones of saurians. As the lacuna in the saurian bone exceeds that of the mammal in the size of its canaliculi, so does the latter exceed that of the bird;* and as they are more numerous and more branched in the bird than in the mammal, so in like manner are they more so in mammalian than in saurian bone.

It is in birds that the Haversian tubes attain their most elegant and varied reticulations, not fortuitously, but with design, and that intimately connected with the life and habits of the animal. In fact, each bone is a study in itself, and involves a knowledge of the muscles that move it as well as of the use it is designed for; and in a bird of flight the shape of the wing, the extent of the surface covered by the quill feathers, whether it is pointed or round, whether the secondary quills are strong or weak, are all matters of deep consideration, and comparison with the internal structure of the bone, which the microscope reveals to the eye. I feel that I need the powers of the consummate naturalist and

* This, of course, is speaking generally. I do not observe much difference between the canaliculi of the hare and those of Bewick's swan as to size. Again, the lacunæ of the mole are as small as those of birds, but then the Haversian tubes totally differ. As a general rule, the bone-cells in birds are smaller than they are in mammifers.

comparative anatomist, to do entire justice to the subject. All I can hope to do is to pioneer the way, and furnish fresh data from which science hereafter may perhaps draw her unerring deductions. My present object is to prove, from a general exposition of the structure of birds, that they had representatives on this planet when the Stonesfield Slate was still the soft mud of a large estuary; and I purpose, for the thorough elucidation of the question, not only to consider the structure of birds, but also of those mammifers and saurians which more or less approach birds in their power of flight, for they are intimately (especially the Pterodactyle) connected with the subject. Amongst mammifers, the bats alone have the power of maintaining a continued flight, by the rapid vibrations of membranous wings, which are in fact but a modification of the arm and hand, so adapted as to enable them to extend a thin canvas by which their bodies are conveyed through the air. To this end the fingers are greatly increased in length, as well as the humerus and radius; the scapula also is large, and lengthened in a slanting direction at its lower portion, for the better attachment of muscular power, and to afford greater support to the stroke of the wing; the clavicles are curved like the furcula of the bird, and perform the united functions of the furcula and coracoids, preventing the compression of the chest and keeping the humerus in its place when acted upon by the pectoral muscles. It must, however, be borne in mind, that there is no deviation in this flying mammal from the plan Nature has laid down in the construction of mammifers; the bat, because it flies, is not a bird, no more than the bird that swims and cannot fly is a fish. If you examine the fin of the penguin, you will observe the same plan of construction that exists in the wing of the eagle; so the wing of the bat is in accordance with the same design that framed the hand of man. Nature can adapt without confusion, and although, as Cuvier says, the bats seem to have the appearances of wings—"Un examen attentif démontre que ce sont de véritables mains, dont les doigts sont seulement un peu plus allongés."

The bones of bats are excessively strong, hard, and semi-transparent, the radius is a long bone curved laterally and inwards like a bow. Along the convex surface runs the extensor muscle with its tendon, which crossing over the carpus becomes connected with the tendons that extend the fingers. On the opposite side of the bone is placed the muscle and tendon that closes the wing. The ulna in bats is either absent or rudimental, the muscles of the forearm are

exceedingly insignificent when compared with those of birds; their bones are harder in texture, and only the very large bats possess Haversian tubes, for even the largest indigenous to this country are without them,* and the *Pteropus,* the largest of the family, has only short and straight ones, and these not at all numerous. Not carrying elastic and powerful quills, the bat does not need the same muscular development that is necessary for the bird, a simpler power of extension and flexion of the wing is all it requires in its forearm; where great muscular power is wanted there it has it. The chest is enormously developed, the ribs are strong and flat, the sternum has a ridge, the scapulæ are approximated to those of the bird, and the whole strength of the animal is concentrated in the chest and shoulders. In fig. 1, plate VI. are shown the Haversian tubes and lacunæ of the *Pteropus,* or flying fox as it is popularly called; the Haversian tubes are more like long lacunæ, and are, in the humerus, straight, unconnected, and not numerous, but the lacunæ are very abundant; these become more fusiform in the phalanges, as may be seen in fig. 2, which represents a phalanx with its medullary cavity of one of our small bats. The canaliculi of the bat are large for mammals. The Haversian tubes in the phalanges of the *Pteropus* are longer and finer than in the humerus, and a slight ramification is seen in the extreme ones. I conceive the reason of the paucity or absence of these tubes in the bats, is to be found in the character of their wings, and the habits of the animal. Bats require light but strong bones, hardly at all flexible, for were they so their great length and slenderness would make the wing so pliable, that it would be powerless in resisting the air, and thereby enabling the animal to sustain itself in flight. Lightness is obtained by numerous lacunæ, and numerous and comparatively thick canaliculi, and no more elasticity is imparted to the bone than is sufficient to preserve its structure, and obviate any fracture, in flight. In the bird, on the contrary, elastic resistance to muscular pressure is of much importance; and hence appears to have arisen that admirable application and adjustment of the Haversian tubes, so conspicuous in the economy of birds. Besides bats, there are other mammifers, such as the *Galeopithecus,* flying *Phalangers,* &c., which, though they do not fly in the true acceptation of the word, yet are enabled to perform flights to some extent in the air by the aid of a

* I have found them in the *jaw,* a thick stem with a few straight branches between the fangs of the teeth. The jaw is a good object of comparison with that of the mole. (*See* p. 76.)

lateral extension of their skin, which being spread out like a parachute sustains them for some time. I have examined the leg-bones of two species of flying *Phalangers,* and a few words will be necessary about them. In such animals lightness and elasticity, but especially the former, are of paramount importance. In the smaller flying *Phalanger,* the Haversian tubes, especially in the tibia, are large and numerous, the lacunæ are very numerous, and the canaliculi large; every particle of unnecessary weight seems to have been abstracted from their bones, that the light animal may float almost like a feather in the air. Fig. 3 gives the appearance of the Haversian tubes in the tibia of the smaller species; they are disposed in the most advantageous manner, running in parallel longitudinal courses, with only an occasional junction between them.

Amongst recent reptiles, the *Draco volans* is enabled, by an extension of its false ribs, to expand a fan-like membrane, by which it can, like the Phalangers, for a little time sustain itself in the air. I have examined also the bones of this most interesting reptile; they are hollow and thin, but strong, without Haversian tubes, and having very numerous lacunæ; the canaliculi are fine for a reptile, but partake, in other respects, of the reptilian characters. The ulna of the *Draco volans* compares very much with that of the frog in the character of its lacunæ; in the femur they approach more those of the *Phalanger;* there is, however, an admixture of roundish lacunæ, but this admixture is apparent also in the bones of bats. As the animal is an agile climber, strength in its bones is as requisite as lightness; and as the parachute is altogether disconnected from its limbs, it would seem to be with the intention of giving them absolute freedom—the long ribs being mobile, and the membrane folding up by the creature's sides until occasion requires its expansion, offering no impediment in the way of its progression (fig. 4 represents the ulna).

Before I make any remarks upon the Pterodactyle, I would describe some of the leading features of the bones of the gannet, and say something of the structure of birds in general. The gannet being peculiarly characterised by the length of its wing-bones, is a very appropriate bird to compare both with the bats and Pterodactyles; its habit is to take its finny prey by falling headlong upon it with immense velocity, and often from some height. It possesses to a surprising extent the power of inflating its body with air, and from the great buoyancy of its body would seem to be incapable of diving, and, though web-footed like the cor-

morant, is said to have no predilection even for swimming; as, however, the force by which it descends, evinced by the cloud of spray it scatters around, must have the primary effect of carrying the bird to a great depth, unless resisted by muscular power, aided by the buoyancy of its body, its legs become powerful instruments in bringing the gannet to the surface so soon as it has secured (as it never fails to do) its prey. The bill of the bird is strong, without clefts for the nostrils; the furcula strong and bowed out, and the portion especially that meets the resistance of the sea is bent down at about a right angle with the coracoid, and it is there excessively strong, with a powerful articulation and a pointed process, extending for half an inch on the inside—taking the furcula, coracoids, and breast-bone together, they form an admirable piece of machinery, adapted to the habits of the bird. The keel of the sternum is small and thrown forwards, so that the outer edge and the furcula constitute an extended arch, very different to the depressed character of the furcula in the shag; the keel of the breast-bone is straight, without any curve, as in the shag. The socket also, where the coracoid fits into the sternum, has a very strong and expanded articulating surface, and there is an impression both in the sternum and the coracoid for an oblong ligament, which braces the coracoid strongly to the sternum; on its outer edge it is not truncated as the shag's, but is shaped like the point of a bill-hook. I will now, however, describe the microscopic structure of some of the principal bones. The humerus, radius, and ulna partake of the characters I have observed in all birds whose wings are long and pointed. In the humerus vertical section (fig. 17), the Haversian tubes do not reticulate, but run nearly parallel, and ultimately converging to a point, from which extends another tube which converges in a similar manner. The lacunæ are long, and, for the most part, narrow; in the transverse section the Haversian tubes appear as round dots, the lacunæ as small, irregular specks, and the canaliculi beautifully reticulate. The ulna compares very nearly with the humerus; in the radius the Haversian tubes are more numerous, more parallel, with fewer connections; the lacunæ also are rather longer. There is nothing particular to notice in the scapulæ, the Haversian tubes observing a pretty similar arrangement; but the furcula, and especially the coracoids, are worthy of particular notice.

In the furcula (fig. 18) the Haversian tubes are not so numerous as in the humerus, have no connections, and the lacunæ are very fusiform. In the coracoid (fig. 19) a

complete change and one anomalous, so far as I have observed, in the structure of that bone in birds, takes place; in the vertical section the Haversian tubes are beautifully and regularly reticulated, the reticulations forming circles generally of a very regular form, and the long and fusiform lacunæ are replaced by roundish ones; in the transverse section the Haversian tubes appear as truncated branches, and the lacunæ are large, which would seem to indicate that their form is pretty circular. The femur of the gannet (fig. 20) very nearly compares with the coracoid, without so much regularity in the Haversian circles; the lacunæ are often roundish oval, sometimes irregular, or long and thickish. In the transverse section (fig. 21) the Haversian tubes appear in parallel rows, with the excised ends of others between; the lacunæ have irregular canaliculi, beautifully reticulated. In the tibia (fig. 22) vertical section the Haversian tubes run longitudinally, with numerous transverse, diagonal connections, characters not at all uncommon in the same bone in other animals; the lacunæ are small sharp-pointed ovals, and differ little either in the vertical or transverse sections. In the tarsus the Haversian tubes are not so numerous, but very much thicker, and also of variable dimensions; in the toes the reticulations are numerous, but not circular, and rather appearing as traces to the longitudinal tubes. In the rib (fig. 24) of the gannet there is a striking correspondence in the characters and paucity of the Haversian tubes with those of the humerus of the *Pteropus;* and we may also notice, in the furcula (fig. 6) of the swift, the same diminution of the Haversian tubes, a bird of very peculiar construction in its wing, with an enormous muscular development. The swifts have by far the shortest humerus, and the longest metacarpal bones and phalanges, of any bird I have dissected.

The sternum of the gannet, being exceedingly transparent, affords an excellent view of the coarser Haversian tubes without the use of the microscope; in the keel they radiate from the thick portion, where the coracoids articulate, like the spokes of a wheel to the edge, appearing looped and braced; in the sternum plate they are bowed outwards from the central line towards the coracoids, being very close together, with numerous cross braces; in the ilia they run longitudinally with much reticulation at the edges; in the flat surface of the back, behind the sockets of the femur, they pass across to the anchylosed vertebræ, being met by others at right angles that extend longitudinally along the narrow part of the bone until they approach the pelvis, when they reticulate until they are lost sight of in the thickness of the

bone. There is nothing particular worthy of notice on this occasion as to the other bones.

The structure of the gannet, so far as I have described it, in the principal bones, admirably exhibits the beautiful adaptation of the microscopic structure of bone to the movements, habits, and well-being of the creature, and in no bone is that adaptation more clearly shown than in the coracoid —the circular reticulations of the Haversian canals in which bone are assuredly designed to enable it to sustain the shock it must receive when the bird impinges on the water; the powerful bill first cleaves the waves, the strong bows of the *furcula* next meet the shock, and the injurious effects of the concussion, which would perhaps be too much for an ordinary coracoid, are obviated by the circular disposition of its Haversian canals. But this is only a single instance. We find wonders of omniscient providence in every skeleton. How admirable is the design displayed in the keel of the sternum. Take that of the heron, for instance; the same tender care is shown for the preservation of the bone when acted upon by the powerful pectoral muscle. It is composed of two plates, with diploë between; the Haversian tubes in the plates meet the pressure at all points. Examine the tibia of the same bird, and it will be found that they are longitudinal in the reticulations. Or if we turn to another kind of bird, the starling, for instance, we find beautiful reticulations in the ulna, with straight Haversian tubes in the coracoid, the very opposite of the gannet. Or if we examine the wing-bone of the razor-bill or guillemot, which is used by the bird to swim with under water, and seldom for flight, we observe not only an external adaptation of the bones, but the microscope shows also that there is an internal one as well. And from the numerous observations which I have made, no doubt whatever remains in my mind as to the important ends and services of the Haversian tubes, lacunæ, and canaliculi.

There are not two bones in animals, unless they are of the same kind, that agree perfectly in the arrangement of the Haversian tubes, or even of the lacunæ; hence the certainty, as our knowledge increases by careful observations, of ascertaining the habits of any animal from the microscopic characters of its bones, a truth which I surmised and hinted at in a previous paper.

That the size of the canaliculi is dependent, as has been supposed, on the size of the blood discs does not appear to be supported by observation; but that it is dependent upon the habits and requirements of the animal observation tends to show. The lacunæ and canaliculi not being of universal

occurrence in fish, seems to show that when they are present it is for some other purpose than the transmission of blood discs to the bone. Again, why should the lacunæ be of different shapes even in the same bone? Surely this can only be explained upon the hypothesis of their connection with the structure of bone, as that is connected with the life of the animal. The canaliculi also seem to differ in size, as in the femur and bone plates of the back of the armadillo. I think the facts I have adduced tend to throw light, not only upon the general structure of bone, but also upon the variation that appears in fishes. In the fin-bone of the sturgeon the lacunæ are assembled in masses, so also in the dermal plates; and the bone of the plates is excessively hard for fishes' bone. It would appear that a combination of strength and toughness is thus imparted to a greater degree than would be given by any homogeneous mass of bone. The very principle has been carried out in the tubular Menai bridge, which has numerous cells or compartments, which add infinitely more to the strength and stability of the structure than if it had been a homogeneous mass; and besides, by the dispensing with superfluous matter, a reduction of specific gravity is also obtained. For ordinary purposes, the gelatinous, homogeneous bones of fishes* seem sufficiently strong for their mode of living, but a much more elaborate structure is requisite in the higher Vertebrata. Only examine the fine structure exhibited in the bones of the lion or the horse—animals which require strength combined with lightness and elasticity or resistance to violent shocks in their bones. The canaliculi of the lion, which possesses great strength, and the horse, which can carry or draw great burdens, are in both numerous and fine. In the whalebone whale, which descends to great depths, they are also numerous and fine; in the elephant, where massive strength is required, they are not numerous. In the *Icthyosaurus*† and *Plesiosaurus*, the canaliculi, though finer than those of some other saurians, are few in number; hence their bone is perfectly distinct from that of mammifers or birds; they have also, at least in parts, straight Haversian tubes. Thus the whole structure of bone is a portion of animal mechanism which, when thoroughly

* Some have, as the cod, Haversian tubes without bone-cells: they are seen well in the vomer.

† Haversian tubes, or the semblance of them, I have only as yet found in the jaw; in the ribs it appears to be an extension of the cancellated structure, of which, in fact, the bone of that animal seems to be composed. The small paddle-bones are very curious, and have a singular complicated set of bone circles at their edges. The peculiar cancellated cavities I at first mistook for Haversian tubes.

understood, may prove of service in the arts and advance the mechanical powers of man. Comparisons with the same bones in birds of similar flight and configuration of the wing are highly useful in elucidating this subject. Take, for instance, such birds as the ring-dotterel, turnstone, dunlin, pigmy curlew, little stint, and other birds of that description, whose mode of flight is so similar that I will defy the most practised sportsman to distinguish one from the other by its flight. Now if we examine a portion of the ulna, taken from the same part of the bone in any one or all of these birds, we shall at once observe a similar and singular correspondence in the disposition of the Haversian tubes. Examine next the ulna of the greensand piper, a bird whose wing is broader than, and not so pointed as, the above mentioned, and whose flight is easily recognised from its congeners by the sportsman, and you will notice an entirely different arrangement of the Haversian tubes, which are reticulated in every direction, while in the rest they observe longitudinal directions; what conclusion can we arrive at, but that these tubes are arranged in accordance with the flight of these birds. The starling, the raven, the jay, &c., have all fine and numerously reticulated tubes, and the secondary quills of all these birds are well developed. In the fowl they are very powerful, and the ulna contains numerous and fine tubes; in the owls the same; in the hawks the Haversian tubes are large and much reticulated, and are easily recognised from those of other birds. It seems, therefore, possible, from the microscopic structure of the bone of a bird, to divine the shape of its wing and the character of its flight, there being a perfect correspondence the one with the other, just as a perfect knowledge of the femur will inform us whether a bird could swim, or only run, or walked; and this may be done even in a fragment of a bone, after we have acquainted ourselves with the general principles by very numerous and exact observations.

In the coracoid, for instance, the ordinary disposition of the Haversian tubes would be longitudinal, braced more or less, because that would be the best arrangement to resist the powerful action of the pectoral muscles. In the gannet, as has been shown, a circular arrangement is preferable, but this is apparently an exception, and connected with the peculiar habits of the bird. The ulna of the razor-bill and guillemot is more reticulated than would primarily be expected in the wing of a bird where the secondary quills are so very weak; but then it must be considered that those birds use their wings much more like fins when under water than as

instruments of flight, as they seldom take wing, but invariably dive, when they are approached, and may be observed to use their wings under the water with surprising ease and agility. The wing, in fact, is more constructed like an oar, and the bones are flat, especially the humerus, and the wrist is strongly braced to the forearm. The ulna and femur of the red-throated diver exhibit a very singular sort of sinuses in the Haversian tubes, which seem to swell out; the structure of these is peculiar, and at present I have not been able quite to make it out, there being a great deal of oily matter in the bones of these birds.* I have observed a structure of bone something similar in the medullary cavity of the ulna of the *Draco volans* (fig. 4). The tibia of the red-throated diver (fig. 5) is introduced on account of this peculiarity. The goosander exhibits somewhat similar reticulations to the Stonesfield fossil.

Having so far given the general features of the microscopic characters of the bones of birds, we may now attempt to grapple with the microscopic structure of that most singular reptile the pterodactyle.

The *Pterodactylus longirostris* perhaps affords us the most perfect means of studying the singular proportions of its skeleton. A larger and less-perfect, but exceedingly useful one, was discovered by Miss Anning, at Lyme Regis, and which is now placed in the British Museum. Also portions of the jaws of a very large kind have been discovered in our Chalk formation, with other bones now supposed to have belonged to a similar animal. From these specimens we learn that the animal was a true saurian, apparently adapted for flight, and for arboreal and terrestrial movements, and instead of possessing, like the bat, an extension of all the fingers, it had only one prolonged, the others being used for progression; it differed also from the bat, in having a well-developed ulna as well as a radius. There did not, however, exist between them the space, that, in birds, is adapted to receive so much muscular power; but as the forearm performed double the duty of that of the bat, we may reasonably suppose that its muscles were more numerous. In the bat, the extensor of the fingers is a small muscle, which, arising from the external condyle of the humerus, and, passing over

* I find in the lower jaw of the *Pteropus* numerous Haversian tubes, parallel with the length of the jaw, and having enlargements or sinuses in them very similar to those in the red-throated diver. Surely this is a further proof of the adaptation of the Haversian tubes to the habits of the animal. The tubes are also branched and connected, very different to the way in which they appear in other parts of the skeleton.

the carpus, sends forth extremely fine tendons over the convex surface of each of the fingers, terminating in the last joint. In the pterodactyle, the digitus auricularis that forms the wing, would seem to require proper extensors and flectors; and we may suppose that the pterodactyle, in some degree, in the use of its limbs, approached the frog; we also may assume it possessed extensores carpi radialis and ulnaris, an extensor digitorum communis, also an extensor proprius digiti minimi (auricularis), as well as flexores carpi radialis and ulnaris, a flexor digitorum communis, a flexor proprius digiti auricularis, and possibly a pronator and supinator. The bird, indeed, has two muscles which occupy the place of the pronator teres, which are not used for pronation but flection. We may therefore imagine that the muscular development of the forearm of the pterodactyle was something between that of the bat, frog, and bird. The presence of quills in the bird has evidently materially affected the muscular development of the forearm; as also their being bipeds involved a greater development of the muscles of the leg, it would be, however, unnecessary to enter upon them. In the pterodactyle, the strain upon the bones of the wing would be principally in the long direction, there being no lateral pressure, from feathers being attached to the bone. In the bird the quill feathers are a very important element, and it has been shown that the Haversian tubes vary according to the shape and uses of the wing; but there is no reason to suppose that any such variations would be required in the pterodactyle. In the *Phalangers* they extend longitudinally; we may therefore suppose that such was principally the case in the pterodactyle; we have every reason to conjecture this from analogy. Take, for instance, the bill of the pelican, which is long; how do they run? longitudinally; or the tibia of a heron? longitudinally also; or in the spiculæ or shafts of bone that shoot across the interior of the humerus of a goose, or in the ordinary coracoid of a bird, the same direction is observed.

Next, with regard to the lacunæ; of what shape would analogy teach us to expect them to be in the pterodactyle? Surely long pointed ovals; as indeed they have been so figured; only the mistake made was the supposing such a shape was peculiarly characteristic of the pterodactyle; whereas the shape of the lacuna is characteristic of no class or order of vertebrate animals, but is only connected with the requirements of the bones of the animal, and may be long or round in the same animal as occasion requires.* The

* Our common roach beautifully exhibits this.

lacunæ, in fact, obey the same laws as the Haversian tubes do, and are placed in that position, and are of that form, which best suits the necessities of the bones they constitute a portion of.

Since I had written the above remarks, I have very opportunely received a portion of a bone from the Chalk, through the kindness of H. Catt, Esq., of Brighton, which precisely exhibits these characters. The Haversian tubes are principally longitudinal, the lacunæ are long like those in the bill of the pelican; and, indeed, the Haversian tubes very nearly compare, especially in size. There is, however, a peculiarity in the bone which I was not altogether prepared for, having observed it in no bird-bones, though I have noticed something like it in the frog. It is the way in which the lacunæ cross.* There appears to be a set running longitudinally, and a set above them running in the opposite direction, which gives a very *marked and peculiar* character to the bone, and makes me think that this bone, which came from the Chalk, and which is a hollow bone with very thin walls of a peculiar texture, is pterodactyle bone; another thing further confirms me in this view, the canaliculi are not numerous like those of birds, and coarser (it is figured in figs. 7 and 14); if so this is a further confirmation of those general principles I laid down in a previous paper on the characters of bone—the pterodactyle, though it could fly like the bird or bat, yet showing its saurian characters, both outwardly and inwardly, in its bones. The fossil bone from Stonesfield, which I have selected for comparison, is in the possession of W. Adams, Esq., of Buriton, Petersfield, who has very kindly furnished me with other most interesting fossils; and I have chosen this from several other supposed fossil bones of birds from Stonesfield, as one of the greatest interest, from its striking similarity in structure to the humerus of the heron. It belonged, however, to a smaller kind than our common heron, and appears from a drawing, (for I have only received fragments of the bone,) to be the distal end of the humerus; the bone has quite the texture of bird-bone in its outward appearance, and is decidedly different from that of the pterodactyle from the Chalk, which looks rather silky, an appearance apparently caused by fine lines on its surface, which the bird-bone is free from.

The vertical section of a portion of this bone gives the following characters: Haversian tubes for a bird of medium

* I have since observed something like this crossing in the skulls of some birds and the bone plates of the armadillo.

thickness; reticulate, but without any precise form or size in the loops, but rather a marked irregularity is shown, some appearing square, others triangular, others oval, in fact of all shapes and sizes; sometimes they somewhat interlace; they do not entirely maintain a uniform diameter, the reticulations are inclined to form combinations, which produces a variety in their appearance, sometimes two or three of a similar shape and size uniting. The lacunæ are numerous, small ovals, and round, but more pointed ones than round. The canaliculi are fine, much branched, and very numerous. That this is the bone of a bird, from the evidence I have adduced, there can be no doubt. My object is rather now to attempt to discover what kind of bird it might have been. We have no reason to suppose it belongs to the *Raptores*, for it does not exhibit their peculiarities of structure, the Haversian tubes being peculiarly large in the diurnal birds of prey. Neither did it with much probability belong to the *Corvidæ*, for in them they are finer and more reticulate; still, neither did it belong to the *Columbidæ* or the gallinaceous family. All the goose, duck, and gull tribes, with the divers, perhaps mergansers, cormorants, &c., may also be excluded, for they have, as far as I have examined them, marked distinctions. By this process of separation we have narrowed the field of our research, which leaves us with the cranes, herons, egrets, and bitterns, and birds of that description, to discover a living representative of this ancient bird. But for the present, I shall only attempt to show that our common heron exhibits a very marked agreement in many particulars.

The bones of the heron, like those of other animals, exhibit a varied adaptation of the Haversian tubes, and certainly do not at all compare with the fossil in some of them, as the tibia for instance; but in the humerus there is a very great similarity, more so than in the ulna or radius. The Haversian tubes in the humerus appear to be constructed on the very same plan, so that a description of the one would be only the counterpart of the other, only they appear rather larger in the heron. The lacunæ have also the same shapes, with nearly the same admixture of round ones; the heron appearing to have a greater number. The canaliculi also perfectly agree. Supposing the fossil bone to have been a humerus, its correspondence with the humerus of the heron would indicate that its wing was similar in shape and its mode of flight corresponding. Should further investigations substantiate this surmise, it will be another triumph of the microscope in the field of science.

Addenda.

The general truth of my observations may be easily tested by an examination of the bones of some of our common animals, such as the hare, rabbit, squirrel, rat, mole, &c. As mere microscopic objects, they will repay all the trouble; and the only apparatus required will be a fine saw, which is best home-manufactured out of the main spring of a watch; a small hand grindstone; a common slate hone; and a piece of leather to guard the fingers. Both a cutting and a writing diamond will also be necessary. If the person is residing in the country, let him take a walk to the first gamekeeper's residence, and ask him to show him where he hangs the vermin; or let him look out for a bush where the mole-catcher hangs his moles; or if he has rabbits for dinner, let him save, to the utter astonishment of his servants, the bones. The dainty morsels conveyed home, a rich mental feast is soon prepared. Let me suppose the operator compares the metatarsal bone of the rabbit or the hare with one of the polecat or the mole. He will find numerous Haversian tubes in those of the rabbit and hare, not half so many in the polecat, and quite a different arrangement in the mole, with complicated reticulations at the ends, and few Haversian tubes, and of a peculiar character, in the shaft, quite distinct from the rabbit, &c. If the whole under jaw of the mole is ground down, the Haversian tubes will be found to send up a tree-like stem between the fangs of the molars, with branches across. The under jaw of the weasel is a very suitable object to compare with the mole; and their distinctive characters are easily recognised. The parietal bone of the mole is also a nice object for comparison with that of the weasel, and in the latter the Haversian tubes are much reticulated, and compare more with those in the joints of the hind metatarsal bones of the mole; that is, they have that complicated character. Now, the weasel is remarkable for a very powerful muscular development in its head; and so its jaws show, in their microscopic characters, great strength of action; and the play of the powerful temporal muscles is registered in the disposition of the Haversian tubes, which are more open in the mole, and less complicated in their character. Let next be picked out one of the little vibrating bones from the ear of the mole—it is itself almost microscopic, but grind it down, and it will be seen to be marvellously full of highly reticulated Haversian tubes; or let the lower jaws of the rabbit, hare, squirrel, and rat, be taken, and let

a piece be sawn out just under the long incisor tooth; the piece from the rabbit will be found to be full of fine tubes parallel with the tooth; that of the hare with coarser and more irregular ones; in the rat few, and only the truncated ends, will be seen; and in the squirrel none at all.* Do not these variations accord with the habits and mode of life of these different animals; the rabbit and the hare can neither gnaw a hole through wood, nor extract the kernel from a nut; but the rat can do the one in a masterly fashion, and the squirrel the other. But I might multiply an infinity of instances until I became tedious, and it is better that microscopists should work them out for themselves. I merely exhibit a few instances out of many from which I have arrived with certainty at the law that governs the texture and composition of bone, which may be thus briefly explained:

That the Haversian tubes are connected with the movements, habits, and mode of life of the living creature in which they may be present.

That the lacunæ obey the same law, and adjust themselves to the strains, pressure, and requisite density of any bone.

That the canaliculi serve it also, and yet without any confusion of the great classes of vertebrate animals.

That all conspire in evincing the admirable unity of design, and the harmonious correspondence of the bones with the muscles, tendons, &c., of an organized being; so that while each living creature obeys the general law, each maintains also its distinctive characters.

* Perhaps an odd one may appear, the cut requires to be carefully made, as there are Haversian tubes on the side of the jaw, but different to those of the rabbit. At the extreme edge there are round holes in the bone, these are much more developed in the rabbit; the course of the bone-cells is irregular, mostly across, whereas they run longitudinally in the rabbit.

On Dysteria; *a new genus of* Infusoria.
By Thomas H. Huxley, F.R.S.

The credit of the discovery of the animal which will be described in the following pages is due to my friend Mr. Dyster, of Tenby; and many of the most important statements regarding its structure and habits are based upon his observations. I think, therefore, I cannot do better than name the genus of which it will form the type after him.*

The creature was found in swarms among the algæ coating the shells of a *Patella* and of a *Littorina* which had long inhabited a marine vivarium. I had the opportunity of examining its structure when visiting my friend during the past autumn, and the following paper must be regarded as an account of Mr. Dyster's work, with some additions of my own.

Dysteria armata (Pl. VII, fig. 13,) has an oval body, $\frac{1}{350}$th—$\frac{1}{250}$th of an inch long, by $\frac{1}{400}$th—$\frac{1}{450}$th broad, which is not altogether symmetrical—the one side presenting a considerable, evenly rounded convexity, while the other, less prominent, is divided by an angulated, longitudinal ridge (m, k) into a smaller, dorsal, and a larger, ventral, area. The edges of both lateral surfaces are sharp and thin; dorsally they are separated by a shallow groove (n, o), but along the ventral line of the body the groove is deep and narrow, and the produced edges of the lateral parietes (n, o) resemble the valves of a bivalve shell.

The ventral and dorsal grooves pass into one another in front, but posteriorly the lateral edges are united for a short space (h). The edge of the left, less convex, side of the body ends anteriorly in an obtuse point (m), which corresponds with the anterior termination of the angulated ridge, and does not extend, by any means so far forward, as the edge of the right side, which remains thin, and forms the anterior extremity of the body.

At the anterior extremity the large oral aperture (a) is seen, just below the angulated ridge and occupying the bottom of a deep fossa, which here takes the place of the dorsal and ventral grooves. The left wall of this fossa is thickened, and projects inwards so as to form a cushion-like lobe, clothed

* Sticklers for classical terminology may however, if they please, derive the name from δύς and τερας, "a difficult sort of monster," or otherwise, from δύστερις, ' perversely disputatious," on account of the controversies to which the obscure structure of the animal may give rise.

with remarkably long cilia; and these cilia are continued into the oral aperture itself—the posterior ones being large, usually directed transversely to the axis of the body, and having at times much the appearance of vibratile membranes.

The bottom of the oral fossa is strengthened by a curious curved rod (*l*), which terminates superiorly in a bifid tooth, while inferiorly it appears to become lost in the wall of the fossa.

But there is a much more prominent and easily distinguishable apparatus of hard parts situated on the opposite or ventral side of the mouth, and extending thence through two thirds of the length of the body (*b*, *c*). It consists of two portions—an anterior, somewhat rounded mass, in apposition with a much elongated, styliform, posterior portion.

It is very difficult to assure oneself of the precise structure of the anterior portion (*f*), but it would seem to be a deep ring, composed of three pieces—two supero-lateral and mutually corresponding (*q*, fig. 14), united with a third, inferior, azygos portion (*p*). The latter is somewhat triangular, with a broad base and rounded obtuse apex; the latter being directed forwards and immediately underlying the oral aperture, while the former is turned backwards, and unites with the two supero-lateral pieces. Each of these is concave internally and convex externally, so as to form a segment of a circle, and presents a clear median space, the optical expression of either a perforation or of a much thinned spot.

The anterior edge of each supero-lateral piece is nearly straight, but the posterior is convex, and it is by this edge that it articulates with or is apposed to, the anterior extremity of the posterior division of the apparatus. Viewed laterally this posterior portion appears to consist of two styles, which are somewhat like nails in shape; their anterior extremities being truncated so as to present a sort of nail-head, while the posterior extremity seems to take to a fine point. Rather in front of the middle of its inferior edge each style seems to give off a short process downwards (*s*), and this process is, in botanical language, decurrent upon the style. Careful examination of the dorsal or ventral aspect of these parts shows that the decurrent process is in fact only the expression of a delicate membrane, which is bent so as to have a ventral convexity, and connects together the two styles (fig. 15). It might be said, therefore, that the posterior part of the apparatus is a triangular membrane, deeply excavated in front, bent so as to be convex downwards, and having its margins thickened and produced into styliform enlargements. This curious piece of mechanism is directed upwards and back-

wards, and terminates in the substance of the body without any apparent connection with other parts.

The whole apparatus is moveable. The posterior portion is pushed against the anterior, and the heads of the styles come into contact with the posterior convex edges of the supero-lateral pieces, and push them forwards; the posterior portion is then retracted, and the whole apparatus returns to its previous arrangement.

In one *Dysteria,* which had swallowed a filament of *Oscillatoria,* so long, that the one extremity projected from the mouth, when the other was as far back in the body as it could go, these movements took place as many as twenty times in a minute.

Mr. Dyster further informs me that, in one of these animals which he saw feed, the frond of *Oscillatoria* was rather "swum upon" than seized, ingestion being accomplished by a smooth gliding motion, apparently without displacement of the styles; but that when the act was completed the styles "gave a kind of snap and moved slightly forwards."

Mr. Dyster is inclined to think that the *Oscillatoria* passed *through* the anterior ring-like portion of the apparatus. I have not seen the animal feed, but on structural grounds I should rather have been inclined to place the oral aperture at (*a,* fig. 13,) and to suppose that the food would pass *above* the anterior ring. The apparatus is destroyed by caustic potash, but remains unaltered on the addition of acetic acid; it is therefore, probably, entirely composed of animal matter.

Immediately above the annular portion of the apparatus, there is invariably present a remarkable amethyst-coloured globule (*t*), apparently composed of a homogeneous fluid. It has on an average a diameter of $\frac{1}{2000}$ inch, and it is entirely lodged in the more convex portion of the body.* In many specimens no other colouring matter than this can be detected, but in some, minute granules ($\frac{1}{75000}$ inch) of a similar colour are scattered through the body. What connection these have with the large constant globule is not clear, since, although the dimensions of the latter vary from the size given above to one fourth or less, no relation could be observed between this diminution and the presence of the granules in other parts of the body.

Behind the amethystine globule the substance of the body has the appearance, common to the Infusoria generally, of a

* In one or two specimens a minute amethystine globule, not more than one sixth the diameter of the large one, was visible immediately below and behind it. Acetic acid destroys the colouring matter.

mass of "sarcode," in which the ingested matters are imbedded, and no clear evidence could be obtained of the existence of any digestive cavity with distinct walls.

A little behind the middle of the body, and towards its ventral edge, there is a clear spheroidal "contractile space" (*d*), which varies a good deal in size. One measured $\frac{1}{1300}$th of an inch in diameter, and became entirely obliterated in the contracted state.

The contractions are not rhythmical, but take place irregularly. On the approach of death the space becomes irregularly and enormously enlarged, until it occupies perhaps a third of the whole contents of the body.

Immediately beyond the contractile space there is a curious oval body (*e*), having its long axis ($\frac{1}{5000}$ in.) directed upwards, and containing a comparatively small central cavity, so that it appears like a thick-walled sac.

Indications strongly suggestive of an inferior opening were sometimes observed in this body, but no demonstrative evidence of the existence of any such aperture could be obtained.

The walls of the ventral groove are provided with long and powerful cilia, a remarkably strong one being attached behind the base of the "appendage," and by their means the animal, when free, is propelled at no very rapid rate through the water. Its more usual habit, however, is to remain fixed by means of the peculiar appendage (*f*), and then the cilia act merely in creating currents, by which nutritive matters are brought towards the mouth.

The appendage referred to is attached to the surface of the body, rather towards the convex side, at the bottom of the ventral groove, and is distant about one fifth of the whole length from the posterior extremity. It is $\frac{1}{800}$th to $\frac{1}{1000}$th of an inch in length, and is not altogether unlike a boot, with a very pointed toe, in shape; and the toe appears to be viscid at its extremity, so as readily to adhere to any foreign object. The appendage then forms a pivot on which the whole body turns about, and this appears to be the habitual and favorite position of the *Dysteria*.

Internally, the appendage contains a canal (*g*), wider above than below, and apparently blind at each extremity.

No "nucleus" could be found, though carefully sought for with the aid of acetic acid.

The occurrence of transverse fission was noticed very distinctly in one case; but it is remarkable that, notwithstanding the great number of specimens which were observed, no other instance of this mode of multiplication came under

the notice of Mr. Dyster or myself. It would appear that the "apparatus" disappears, and is reproduced during fission, for in the single case observed, mere rudiments of it were to be seen in each half of the strongly constricted mass.

Dysteria has not hitherto been observed to become encysted, although this condition has been carefully sought for.

There can, I imagine, be little doubt as to the true systematic position of *Dysteria*. The absence, in an animal which takes solid nutriment, of an alimentary canal with distinct walls, united with the presence of a contractile vesicle, with the power of transverse fission, and with cilia as locomotive organs, is a combination of characters found only in the *Infusoria*. In this class, again, the existence of a sort of shell or *lorica*, constituted by the structureless outer layer of the body; the presence of a submarginal ciliated groove around a large part of the margins of the body; and the inequality of the two lateral halves, leave no alternative save that of arranging *Dysteria* near or in the *Euplota* of Ehrenberg.

Indeed there is one species figured by Ehrenberg ('Infusions-thierchen,' p. 180, pl. 42, fig. xiv), *Euplotes macrostylus*, found at Wismar, on the Baltic, which, in general aspect, and in the possession of a foot-like appendage, so closely resembles the present form, that were it not for the absence of any allusion to the amethystine globule, or to the "apparatus," I should be strongly inclined to think it identical with *Dysteria*. That an internal armature is not inconsistent with the general plan of the *Euplota*, is shown by *Chlamidodon*, whose apparatus of styles would probably repay re-examination.

Notwithstanding certain analogies which might be shown to exist between the manducatory apparatus of some Rotifera (see, *e. g.*, that of *Furcularia marina*, figured by Mr. Gosse, in his excellent memoir, 'Phil. Trans.,' 1846) and the "apparatus" of *Dysteria*, I see no grounds for regarding the latter as in any way an annectant form between these groups.

On the Origin *of* Greensand, *and its* Formation *in the* Oceans *of the* Present Epoch. By Professor J. W. Bailey, West Point, New York.

(Communicated by the Author.)

As an introduction to the subject of this paper, it is proper to refer to various observations which have been made of facts intimately related to those which I wish to present. That the calcareous shells of the Polythalamia are sometimes replaced by silica, appears to have been first noticed by Ehrenberg, who, in a note translated by Mr. Weaver, and published in the 'L. E. and D. Philosophical Journal' for 1841, vol. xviii, p. 397, says:

"I may here remark that my continued researches on the Polythalamia of the Chalk, have convinced me that very frequently in the earthy coating of flints, which is partly calcareous and partly siliceous, the original calcareous shelled animal forms have exchanged their lime for silex without undergoing any alteration in figure, so that while some are readily dissolved by an acid, others remain insoluble; but in chalk itself, all similar forms are immediately dissolved."

The first notice of *casts* of the cells and soft parts of the Polythalamia was published by myself in the 'American Journal of Science' for 1845, vol. xlviii, where I stated as follows:

"The specimens from Fort Washington presented me with what I believe have never been before noticed, viz., distinct *casts* of Polythalamia. That these minute and perishable shells should, when destroyed by chemical changes, ever leave behind them indestructible memorials of their existence, was scarcely to be expected, yet these casts of Polythalamia are abundant and easily to be recognised in some of the Eocene Marls from Fort Washington." This notice was accompanied by figures of well-defined casts of Polythalamia (l. c., pl. iv, figs. 30, 31).

Dr. Mantell also noticed the occurrence of casts of Polythalamia and their soft parts, preserved in flint and chalk, and communicated an account of them to the Royal Society of London, in May, 1846. In this paper he speaks of the chambers of Polythalamia as being frequently filled with chalk, flint, and *silicate of iron*. ('Phil. Trans.,' 1846, p. 466.) To Ehrenberg, however, appears to be due the credit of first distinctly announcing the connection between the Polythalamia and the formation of Greensand, thus throwing the first light upon the origin of a substance which has long been a puzzle to geologists. In a notice given by this distinguished

observer upon the nature of the matrix of the bones of the Zeuglodon from Alabama (see 'Monats-Bericht,' Berlin, February, 1855), he says:

"That Greensand, in all the numerous relations in which I have as yet examined it, has been recognised as due to the filling up of organic cells, as a formation of stony casts (Steinkernbildung), mostly of Polythalamia, was stated in July of the preceding year." He then refers to the Nummulite Limestone of Traunstein, in Bavaria, as rich in green opal-like casts (Opalsteinkernen) of well-preserved Polythalamian forms, and mentions them as also occurring, but more rarely, in the Glauconite Limestones of France. He then proceeds to give an account of his detection of similar casts in the limestone adhering to the bones of the Zeuglodon from Alabama, and states that this limestone abounds in well-preserved brown, green, and whitish stony casts of recognisable Polythalamia. This limestone is yellowish, and under a lens appears spotted with green. These green spots are the Greensand casts of the Polythalamia, and they often form as much as one third of the mass. By solution in dilute chlorohydric acid, the greensand grains are left, mixed with quartzose sand, and with a light yellowish mud. The latter is easily removed by washing and decantation. The casts thus obtained are so perfect, that not only the genus, but often the species of the Polythalamia, can be recognised. Mingled with these are frequently found spiral, or corkscrew-like bodies, which Ehrenberg considers as casts of the shells of young mollusks.

With reference to the perfection of these casts of the Polythalamia, and the light they throw upon the structure of these minute animals, Ehrenberg remarks:

"The formation of the Greensand consists in a gradual filling up of the interior space of the minute bodies with a green-coloured, opal-like mass, which forms therein as a cast. It is a peculiar species of natural injection, and is often so perfect, that not only the large and coarse cells, but also the very finest canals of the cell walls, and all their connecting tubes are thus petrified, and separately exhibited. By no artificial method can such fine and perfect injections be obtained."

Having repeated the experiments of Ehrenberg upon the Zeuglodon Limestone, I can confirm his statements in every particular, and would only add that, besides the casts of Polythalamia and small spiral mollusks, there is also a considerable number of green, red, and whitish casts of minute anastomosing tubuli, resembling casts of the holes made by burrowing sponges (Cliona) and worms.

In the 'Berlin Monats-Bericht,' for July, 1855, Ehrenberg gives an account of very perfect casts of Nummulites, from Bavaria and from France, showing not only chambers connected by a spiral siphuncle, but also a complicated system of branching vessels. He also gave at the same time an account of a method he had applied for the purpose of colouring certain glass-like casts of Polythalamia, which he had found in white tertiary limestone from Java. This method consists in heating them in a solution of nitrate of iron, by means of which they can be made to assume different shades of yellow and brownish red, still retaining sufficient transparency when mounted in balsam to show the connection of the different parts.

The interesting observations of Ehrenberg which are alluded to above, have led me to examine a number of the cretaceous and tertiary rocks of North America in search of Greensand and other casts of Polythalamia, &c. The following results were obtained:

1st. The yellowish limestone of the cretaceous deposits of New Jersey occurring with *Teredo tibialis*, &c., at Mullica Hill, and near Mount Holly, is very rich in Greensand casts of Polythalamia and of the tubuliform bodies above alluded to.

2d. Cretaceous rocks from Western Texas, for which I am indebted to Major W. H. Emory, of the Mexican Boundary Commission, yielded a considerable number of fine Greensand and other casts of Polythalamia and Tubuli.

3d. Limestone from Selma, Alabama, gave similar results.

4th. Eocene limestone from Drayton Hall, near Charleston, South Carolina, gave abundance of similar casts.

5th. A few good Greensand casts of Polythalamia were found in the residue left on dissolving a specimen of marl from the Artesian Well at Charleston, S.C.; depth 140 feet.

6th. Abundance of organic casts, in Greensand, &c., of Polythalamia, Tubuli, and of the *cavities of Corals*, were found in the specimen of yellowish limestone, adhering to a specimen of *Scutella Lyellii* from the Eocene of North Carolina.

7th. Similar casts of Polythalamia, Tubuli, and of the *cavities of Corals*, and spines of Echinus, were found abundantly in a whitish limestone adhering to a specimen of *Ostrea sellæformis* from the Eocene of South Carolina.

The last two specimens scarcely gave any indications of the presence of Greensand before they were treated with dilute acid, but left an abundant deposit of it when the calcareous

portions were dissolved out. All the above mentioned specimens contained well-preserved and perfect shells of Polythalamia. It appears from the above, that the occurrence of well-defined organic casts, composed of Greensand, is by no means rare in the fossil state.

I come now to the main object of this paper, which is to announce that the formation of precisely similar Greensand and other casts of Polythalamia, Mollusks, and Tubuli, is now going on in the deposits of the present ocean. In an interesting report by Count F. Pourtales, upon some specimens of soundings obtained by the U. S. Coast Survey in the exploration of the Gulf Stream (see 'Report of U. S. Coast Survey,' for 1853, Appendix, p. 83), the sounding, from Lat. 31° 32′, Long. 79° 35′, depth 150 fathoms, is mentioned as "a mixture in about equal proportions of Globigerina and black sand, probably greensand, as it makes a green mark when crushed on paper." Having examined the specimen alluded to by M. Pourtales, besides many others from the Gulf Stream and Gulf of Mexico, for which I am indebted to Prof. A. D. Bache, the Superintendent of the Coast Survey, I have found that not only is Greensand present at the above locality, but at many others, both in the Gulf Stream and Gulf of Mexico, and that this Greensand is often in the form of well-defined casts of Polythalamia, minute Mollusks, and branching Tubuli, and that the same variety of the petrifying material is found as in the fossil casts, some being well-defined Greensand, others reddish, brownish, or almost white. In some cases I have noticed a single cell, of a spiral Polythalamian cast, to be composed of Greensand, while all the others were red or white, or *vice versa*.

The species of Polythalamia whose casts are thus preserved, are easily recognisable as identical with those whose perfectly preserved shells form the chief part of the soundings. That these are of recent species is proved by the facts that some of them still retain their brilliant red colouring, and that they leave distinct remains of their soft parts when treated with dilute acids. It is not to be supposed, therefore, that these casts are of extinct species washed out of ancient submarine deposits. They are now forming in the muds as they are deposited, and we have thus now going on in the present seas a formation of Greensand by processes precisely analogous to those which produced deposits of the same material as long ago as the Silurian epoch. In this connection, it is important to observe that Ehrenberg's observations and my own establish the fact that *other* organic bodies than Polythalamia produce casts of Greensand; and it should also be

stated that many of the grains of Greensand accompanying the well-defined casts are of wholly unrecognisable forms, having merely a rounded, cracked, lobed, or even coprolitic appearance. Certainly many of these masses, which often compose whole strata, were not formed either in the cavities of Polythalamia or Mollusks. The fact, however, being established beyond a doubt, that Greensand does form casts in the cavities of various organic bodies, there is a great probability that all the masses of this substance, however irregular, were formed in connection with organic bodies; and that the chemical changes accompanying the decay of the organic matter have been essentially connected with the deposits in the cavities, of green and red silicates of iron, and of nearly pure silica. It is a curious fact in this connection, that the *siliceous* organisms, such as the Diatomaceæ, Polycistineæ, and Spongiolites, which accompany the Polythalamia in the Gulf Stream, do not appear to have any influence in the formation of casts.

The discovery by Professor Ehrenberg, of the connection between organic bodies and the formation of Greensand, is one of very great interest, and is one of the many instances which he has given to prove the extensive agency of the minutest beings in producing geological changes.

Further Observations *on* Vegetable Growth.

By the Hon. and Rev. Sidney Godolphin Osborne.

It may interest the readers of the 'Journal' to know that further observation has given me a deeper insight into the structure of the wheat plant in the earliest stage of its growth. I find there is a "circulation" in every one of the long suckers put forth from the roots; it may be seen very plainly under a power of 800. Although I can trace it with ease along the outer edge of each sucker, running from the root towards the blunt point, I cannot trace any current returning towards the root.

In the case of the spiral fibre in the early plumule, I now find it to have in every case its own investment; that, in fact, it is within a tube of very thin cellular texture. By careful management of the light, lines running vertically the whole length of this tube can be seen; I presume these to be the outlines of a fine wall of cells, of which this tube is formed. The coils of fibre, if attached at all to this tube, are only partially so, as I have succeeded by pressure in extending a

coil without disturbing in any way the tube itself. That they exercise considerable pressure upon the tube, at the points where the coils are close, is quite evident by the extension that they there clearly give to it.

Although I have failed in every endeavour to make out the existence of spiral fibre in the grain of wheat, in other vegetables I can clearly trace it, but only in the embryo seed. A very fine section of a young "vegetable marrow," made so as to pass through the embryo seeds, will show coils of spiral fibre passing from the flesh of the fruit into these seeds; and at the narrow extremities of each seed, it can with ease be made out with a power of 500. The embryo seeds are, in fact, connected with the fruit by a small bundle of this fibre. I believe this to be the case with the wheat, and I have little doubt but that a careful dissection of the attachment of each grain in an ear of such corn, made at the time when the grains are just assuming their form, would prove it.

I have been much interested by a continued close study of the "double ovate" vesicles to be ever found imbedded in the plasm *in* which, if not *from* which, the root cells of the wheat root are formed. I have the strongest impression that these are the earliest organisms of plant life, so far, at least, as the roots of plants are concerned. I will not now hazard the publication of all the extraordinary features I have observed in them; one, however, not the least extraordinary, I will mention. I have now preparations of the formative matter of the wheat root, sealed hermetically more than six months since, and floating in "Thwaites's fluid," the double ovate cells of which are in as active a motion at this time as they were the day I put them up from the growing root. By the use of the twelfth power B eye-piece, and good light, they may be seen to have taken up the pigment in which I have grown the plants; indeed, I am now satisfied it is by their close aggregation within the cells of the roots, that I get the rich colour I do, when the plants are grown in coloured *media*. The divisions of my micrometer eye-piece, with the twelfth power, as given me by Mr. Ross, are $\frac{1}{13500}$ (0·000074). One of these active vesicles will occupy rather more than one of these divisions. The movement of these minute bodies is very different from the molecules of gamboge and other substances; I have never seen anything the least resembling it, except in preparations I have made from prepared glasses, exposed for a time to the atmosphere in the early days of summer, when the air is full of spores.

What life it is I know not, but I believe it to be positively *life*.

On STRIATED MUSCULAR FIBRES *in the* SKIN *of the* HUMAN LIP. By Dr. WOODHAM WEBB, Lecturer on Histology at the Grosvenor Place School of Medicine, London. (Plate VII, fig. 16.)

KÖLLIKER, Eylandt, Henle, and Lister have accurately enough described the unstriped muscular fibres connected with the hair-sheaths and sebaceous glands in the scalp and other parts of the skin. These are now well known by the significant name of *Arrectores pili,* given to them by Eylandt. Huxley has also figured branched muscular fibres of the striated kind attached to the vibrissæ of the rat. But no notice has yet been published of a series of striped fibres and bundles of fibres existing in the human lip, and having there corresponding relations and actions. Such, however, may be found proceeding, in numerous small groups, from the orbicularis oris, and passing outwards through the corium. These minute bundles of muscular fibre are thrown off from the outer layer of the orbicularis oris, and are to be traced in compact masses to the base of the hair-sheaths and sebaceous glands. At this point the fibres separate, spread themselves over the surface of the gland, form more or less close attachments to the membrane investing the glandular structure, and appear to interlace with each other. Above the gland, they are reduced to the condition of independent fibres, diverge somewhat widely, so that those from adjoining glands cross each other, and continuing outwards, gradually lose their striated character; becoming at the same time much smaller. They ultimately merge into the connective tissue which forms the basement membrane of the papillæ, in the same manner as the muscular fibre of the tongue is described by Dr. Hyde Salter to pass directly into the bundles of the submucous connective tissue. It has not been observed that any of these ultimate fibres are branched; nor are there any traces of the coexistence of non-striated muscular appendages. The points of attachment below, around, and above the glands and hair-sheaths, sufficiently explain the action of these muscles; the nature of the part in which they are situated accounts for the deviation in the arrangement of the respective structures from that prevailing elsewhere; and it may easily be understood how, though so small individually, these muscles, by their conjoint action, assist in determining the expression of the parts about the mouth.

TRANSLATIONS.

Algarum Unicellularium Genera *nova et minus cognita, præmissis* Observationibus *de* Algis Unicellularibus *in genere.*

New and less known Genera of Unicellular Algæ, *preceded by* Observations *respecting* Unicellular Algæ *in general.* By Alex. Braun. (Lipsiæ, 1855; with six Plates.)

Continued from No. XVII, p. 16.

In one respect only does the question appear to require more strict definition, a careful distinction should be made between *Algæ* which are unicellular only in the looser sense of the term, and those which have a more direct title to the name; for several genera of *Algæ* (among the *Palmellaceæ, Desmidiaceæ,* and *Diatomaceæ*), though formed indeed of isolated cells, or of cells loosely connected merely by a gelatinous matter, nevertheless exhibit a vegetative division of the cells, by means of which they are multiplied through a more or less extended series of generations, until the cycle of vegetation terminates in the production of *gonidia* or of spores. In these genera, therefore, as in the multicellular *Algæ,* divers generations of cells are to be distinguished:—1, *ordinal,** which by their conjunction constitute the vegetating individual, either continuous, or broken up and dissected into parts (individuals of a lower order); and 2, *cardinal,*† by which fructification is accomplished, and the transition to a new series of ordinal cells effected. It is obvious, therefore, that *Algæ* of this kind, since they really pass through a multicellular vital cycle, and are unicellular only in appearance (pseudo-unicellular), must, in a biological sense, be regarded as multicellular; whence it is readily seen that they cannot be separated from other multicellular *Algæ* formed of contiguous cells, by any strict line of demarcation either morphological‡ or systematic.§ Unicellular *Algæ,* in

* 'Reihengenerationen,' Näg. einz. Algen, p. 25.

† 'Uebergangsgeneration,' ibid. (Schlussgeneration).

‡ Compare the *Diatomaceæ* and solitary *Desmidiaceæ* with the catenated forms: *Tetraspora* with the *Ulvæ,* through *T. bullosa,* which is referred by Thuret to the *Ulvaceæ,* under the name of *Monotrema;* compare also *Hormospora* with *Ulotriche, Stichococcus* with *Hormidium, Synechococcus* with *Oscillaria,* &c.

§ The *Diatomaceæ* and *Desmidiaceæ,* placed, according to Nägeli's classi-

the wider sense of the term, would be distinguished by a more essential character, if with them were conjoined all those which exhibit similar generations of cells, so that a specific idea is equally represented* in each cell, either free or united with others. But such a character, if the matter be more closely scrutinised, is scarcely anywhere really exhibited among *Algæ* endowed with the property of vegetative division, since, at any rate, the cells of the cardinal generation differ from the rest physiologically and sometimes also morphologically; and in the cells themselves of the ordinal generations some differences, which can hardly be regarded as fortuitous, and chiefly relating to magnitude,† may be observed. It is obvious, therefore, that in all these instances a specific idea can only be really completed by a certain cycle of cells.

The more strictly unicellular *Algæ*, however, present conditions altogether different, their entire and undivided vital cycle being completed by the continuous evolution of a single cell. In them there is no division of the cell throughout the whole course of vegetation, nor any multiplication and diversity of generations, since the same cell successively assumes the functions of *thallus* and of organ of fructification (of gonio-cyst or sporo-cyst, *vulg.* "sporangium"). But among these also some diversity is presented, by which the forms, in the strictest sense of the term, unicellular, are separated from those which, in a certain sense, hold an ambiguous place; for the unicellular *Algæ* differ with respect to the generation of the *gonidia*, which in some is effected by the direct separation and transformation of the cell-contents,‡ and in others is preceded by a previous repeated act of division.§ That the former are unicellular, in the strictest sense of the term, no one will doubt, since they exhibit no series of generations within the vital cycle; but the latter, which, after the unicellular state of vegetation, pass through intermediate *quasi* multicellular states, in order to complete their fructification, might be regarded as multicellular *Algæ*, if indeed the term cells could properly be applied to those transitory generations, composed merely of portions of the plasma of the primary

fication, among the unicellular *Algæ*, are very closely allied to the *Zygnemaceæ* among the multicellular *Algæ;* and in the same way the *Chroococcaceæ* are intimately related to the *Nostochineæ* (in the wider sense).

* Nägeli, einz. Alg., pp. 2 and 3.

† Compare the *Diatomaceæ* and *Desmidiaceæ* (especially the *Closteria*), as well as the *Glæocapsæ*, *Tetrasporæ*, &c.

‡ As in *Hydrocytium*, *Codiolum*, *Chytridium*, *Bryopsis*, *Botrydium*, and *Hydrodictyon*.

§ In *Cystococcus*, *Characium*, and *Pediastrum*.

cell (primordial or naked cells as they are termed), scarcely separated by any proper membranes, and presenting no indication of vegetative evolution. However this may be, it is clear that these transitory generations perform the functions of imperfect *gonidia*, destined to undergo a second division, on which account, and from their close similarity in habit* and other characters, this ambiguous section should perhaps be referred to the unicellular type, though it cannot be denied that a connecting link with the multicellular *Algæ* (pseudo-unicellular) is presented in it.

From the *unicellular Algæ*, besides the *pseudo-unicellular*, are also to be distinguished those which are typically *bicellular*, producing two heterogeneous cells, one of which constitutes a *thallus*, the other a *goniocytium* or a *sporocytium*. These plants have, it is true, a unicellular thallus, but have also *gonocytia* or *sporocytia* distinct from and exclusive of the *thallus*. The simplest state, such as is exhibited in extremely depauperate specimens of *Vaucheria*, represents a simple vegetating cell, terminated above in a single *goniocytium*. But generally a more complex bicellular type is exhibited in those forms, the vegetating cell branching in various ways, and consequently supporting several fructification-cells, which differ in different cases, according as they constitute *gonidia* and *spores*. In *Codium* but one mode of fructification (that of *gonidia*, within a *goniocytium*) is known, whilst in *Vaucheria*, *Achlya*, and *Saprolegnia*, a double, or even threefold kind of fructification may be observed.†

The author is not acquainted with a *tricellular* type of evolution among the true *Algæ*; but in the mycetoid plants analogous to *Algæ*,‡ this mode of evolution is manifested very distinctly in *Pilobolus*,§ which is truly a tricellular *fungillus* whose thallus is divided into two cells—a root, as it were, and a stem, which supports a third cell (*sporocytium*).

* Compare, for instance, *Characium* with *Hydrocytium*, *Pediastrum* with *Hydrodictyon*.

† The corniculate ramules of *Vaucheria* which accompany the lateral sporocytia containing hypnospores, from the observations of Karsten (Bot. Zeit., 1852, p. 86), which, however, should be received with caution, the author scarcely doubts to be *goniocytia*, emitting lesser zoogonidia (microgonidia). [On this point *vide* Pringsheim's observations, given in the 'Quarterly Journal of Microscopical Science,' vol. iv.] Hence it will be perceived that *Vaucheria* presents a triple apparatus of fructification.

‡ The mucorine *Fungi*, amongst which *Pilobolus* belongs, together with the closely allied *Saprolegniæ* (including *Leptomitus lacteus*), wholly agree with the *Vaucheriaceæ* (and with the *Codieæ*) in their usually unicellular *thallus*, and the endogenous formation of their spores.

§ Cohn, in Nov. Acta Nat. Curios., 23, 1, p. 492, tab. 51.

But to return to the true unicellular *Algæ*. The number of genera belonging to this class at present known is small, but amongst them great diversity exists. The greatest care is requisite in their determination as independent organisms; nor should this be decided, unless every stage of their evolution from beginning to end is known. Especially must we be careful not to regard the young state of *Algæ* of a higher order, or depauperate generations (*pauperculæ*), as unicellular genera.* Nor, on the other hand, should less caution be observed not to confound associations of unicellular *Algæ* with the multicellular. For in several genera of the latter class the closest and most regular associations of distinct individuals, which at first are sometimes freely motile, are met with. These forms are in the highest degree fallacious, presenting as they do a false resemblance to a cellular texture. They are well worthy of more particular attention, and a comparison of them with the families or colonies of the pseudo-unicellular *Algæ* may not be considered superfluous. These compound bodies, however, in *Algæ*, more or less properly speaking unicellular, formed by the association of cells, are so well treated of by Nägeli ('Einz. Algen.,' p. 24), as regards their origin, composition, and diversity of form, that the author has scarcely anything to add beyond certain distinctions, belonging more especially to unicellular *Algæ* in the stricter sense of the term. For the associations of *Algæ*, less properly so termed, or of the pseudo-unicellular class, are always formed by the vegetative multiplication of cells; and those of the really unicellular by true propagation: the former, therefore, merely represent individuals divided into more or less independent and loosely coherent parts, and cannot be distinguished by any strict definition from a continuous thallus; whilst the latter are really constituted of several individuals distinct from the first. The associations of pseudo-unicellular *Algæ* are evolved from a single cell (spore or *gonidium*) by successive multiplication, the number of cells gradually increasing through a more or less determinate series of generations; whilst the associations of the more strictly unicellular *Algæ*, on the contrary, are constituted of several cells (*gonidia*), distinct *ab origine*, the number of cells never increasing, owing to the absence of any vegetative division; the former, in fact, constitute *families* of cells, pro-

* *Pauperculæ* of this kind, that is to say, individuals normally depauperate, and curiously simulating 1-2 cellular parasitic plants, are produced in some species of *Œdogonium*, as well as in *Bulbochæte*, from microgonidia. *Vide* Braun, 'Rejuvenescence,' p. 151; Ant. de Bary, in 'Mus. Sekenb.,' 1854, pp. 63, 87, t. iii and iv.

ducing, from a single mother-cell, secondary, tertiary, and quaternary, &c., cells up to a certain stage; whilst the latter, formed, as it were, from sister-cells, and never producing any offspring admitted into the society, might rather be termed *cænobia*. One exception to this rule only is known to the author, presented in *Sciadium*, a strictly unicellular plant, but which is nevertheless evolved into a true family, formed, however, not by vegetative multiplication, but by way of propagation.

The author, therefore, from the foregoing considerations, would classify the associations of the lower *Algæ*, according to their principal differences, in the following manner:

A. An association evolved by successive generations of cells from a single mother-cell (spore, *gonidium*): FAMILIA;

a. Cells arising by vegetative division (more or less distinct, but retained in connection by means of the parent membrane): the family representing an individual biologically single (a thallus broken up):

α. Order of cells immutable: *Hormospora! Palmodactylon! Merismopædia! Tetraspora, Glæocapsa, Glæocystis;*

β. Order mutable: *Nephrocytium, Glæothece, Aphanothece, Apiocystis.*

b. Cells arising by true propagation: FAMILIA CÆNOBIOTICA, composed of individuals really distinct: *Sciadium.*

B. Association constituted of several cells (*gonidia*) originally distinct: CÆNOBIUM;

a. Constituted of zoogonidia, which become united after a motile stage, and grow into immotile cells;

α. Order immutable: *Hydrodictyon;*

β. Order mutable: *Pediastrum.*

b. Of immotile gonidia, which grow into immotile cells;

α. Order immutable: *Scenedesmus, Sorastrum;*

β. Order mutable: *Cœlestrum?*

c. Of immotile gonidia, which change into vibratory cells;

α. Order immutable: *Gonium, Stephanosphæra, Synaphia;*

β. Order mutable: *Pandorina.*

To this arrangement another is subjoined, in which a synoptical comparative view is given of the differences exhibited in the lower *Algæ*, derived from the *simple* or *multiple* generation of cells described above:

A. MONOCYTIDEÆ, or Unicellulares, exhibiting a unicellular vital cycle:

a. True, or unicellular in the strictest sense of the term; no transitional generations of *gonidia;*

α. *Eremobiæ*, growing with a solitary cell: *Protococcus*, Näg., *Hydrocytium, Codiolum, Ophiocytium, Polyedrium?* (*Chytridium*);

β. *Cænobiæ*, the unicellular individuals associated into a *cænobium* (pseudo-multicellular): *Hydrodictyon;*

γ. *Synoicobiæ*, associated into families (pseudo-multicellular): *Sciadium:*

b. Ambiguous, *i.e.* forming *gonidia* by means of transitional generations, and indicating the transition to the multicellular *Algæ:*

α. *Eremobiæ*, as above: *Cystococcus, Characium;*

β. *Cænobiæ*, as above: *Pediastrum, Scenedesmus, Gonium, Pandorina, Stephanosphæra, Synaphia.*

B. Oligocytideæ, the vital cycle limited to few cells; cells, two or three, heterogeneous.

a. Bicellular: *Codium, Vaucheria* (*Saprolegnia, Achlya*);

b. Tricellular: *Pilobolus.*

C. Polycytideæ, or multicellular, the vital cycle including many cells:

a. *Homœocytideæ*, cells (the vegetative at any rate) subsimilar:

α. *Schizocytideæ*, cells more or less separate from each other (pseudo-unicellular):

* *Choristobiæ*, cells quite separate: *Navicula, Closterium, Pleurococcus, Chroococcus.*

** *Synæcobiæ*, cells loosely connected by gelatinous envelopes, associated into families: *Schizonema, Hormospora, Palmodactylon, Palmella, Hydrurus.*

β. *Synechocytideæ*, cells contiguous (the family of cells becoming a continuous *thallus*): *Himantidium, Desmidium, Spirogyra, Oscillaria.*

b. *Neterocytideæ*, cells obviously differing in nature: *Nostoc, Cylindrosporum, Rivularia, Œdogonium, Bulbochæte,* &c.

In this classification, the first section (A) alone contains *Algæ*, in the author's opinion, truly unicellular, although *Algæ*, unicellular according to Nägeli's definition, are included in sections A, B, and C, *a*, α and β (in part). It need scarcely be remarked, however, that all the sections in this classification taken from single characters are merely artificial, and do not correspond with families founded upon a real and intimate affinity. Nor, indeed, would it seem that all unicellular *Algæ*, in the stricter sense of the term, are of necessity so closely allied as to be included in a single and peculiar tribe; points, the discussion of which is reserved till the description of each genus is given.

Some observations remain to be made respecting the terminology of the *Algæ*. The vegetative substance of the *Algæ*, as regards the varieties of forms, has received various appellations, but by Kützing it has been termed in general *phycoma*, for which the author would substitute *phytoma*, a

term extending to the vegetative substance of all plants. Were the term *phycoma* to be admitted, the *phytomata* of other classes of plants would also require to be designated by special names, *e.g.*, for the Fungi *mycoma,* for the Mosses *bryoma,* for the Ferns *pteridoma,* would have to be adopted, which the author regards as superfluous, since only two kinds of *phytomata* need be distinguished on morphological grounds, viz., *phytoma cormodes* for the phanerogamous and higher cryptogamous plants, and *phytoma thallodes* for the lower cryptogams. The author, therefore, thinks it would be right to employ the term *thallus* to designate the vegetative body of both the Lichens and Fungi.

The cell is by him expressed by the Greek term *cytis,* which is also employed by others, whence the derivatives *cytioblastus, cytioplasma, cytioderma.*

(*To be continued.*)

Remarks on DR. STEIN'S DOCTRINE *respecting the* ACINETA-FORMS. By DR. H. CIENKOWSKI.

(From the 'Bulletin de la Classe Physico-Mathematique de l'Academie Imperiale des Sciences de St. Pétersbourg,' January, 1855.)

STEIN'S observations respecting the Infusoria have justly excited great astonishment among the micrographers. The wonderful phenomena of "Alternation of Generations" have been represented by this observer as occurring more extensively among the Protozoa than perhaps in any other class of animals. The *Vorticellina,* in consequence of a process of "encysting," are transformed into *Acinetæ,* and these again into Vorticellæ, by means of internal motile embryos, which are emitted from them.

In order to arrive at an independent judgment with respect to these Acineta-forms, I have examined the following species: *Podophyra fixa,* Ehr., the Acineta connected with it, and *Vorticella microstoma,* Ehr. Now, if the doctrine be substantial and not merely hypothetical, two important statements should be borne out by facts; viz., the transition of the *Vorticellæ* into *Podophryæ,* and, secondly, the transformation of the offspring of the *Podophryæ* into *Vorticellæ.*

Stein arrived at the former conclusion by comparing *Podophryæ* remaining at an early stage of development with metamorphosed *Vorticella-cysts.* Among *Podophryæ* of the

common form, others not unfrequently presented themselves whose spherical body was enclosed in a usually wide case, which was produced into a hollow funnel-shaped peduncle. This case presented equidistant annular constrictions, alternating with acute, parallel, angular ridges. Most of the individuals in this condition were unarmed; but occasionally Stein noticed them to be furnished with numerous capitate tentacles.

On the other hand, Stein observed that, in the older cysts of *Vorticella microstoma*, the enclosed parent-vesicle had undergone a change. Its naturally smooth, even surface, almost everywhere closely fitted to the cavity of the cyst, was in many places separated from the cyst-wall and depressed towards the interior, in deep sinuosities, whilst in other parts the parent-cyst was protruded into cæca—which from their considerable size impinged with such force against the wall of the cyst, that it appeared as if they were endeavouring to rupture it.

These metamorphosed stages of the Vorticella-cysts, as Stein further remarks, appeared to merge imperceptibly into the above-described undeveloped conditions of the *Podophryæ;* it being assumed that the vesicular dilatations of the parent-vesicle within the Vorticella-cysts were only the commencement of a still greater enlargement of the parent-vesicle; whose forcible extension ultimately ruptured the walls of the containing cyst. In cases where the cyst is distended uniformly by the parent-vesicle contained within it—which would happen when the cyst is free all round—the Vorticella-cyst with its contents would of course be transformed into an *Actinophrys;* but when this uniform distension in all directions is in any way prevented, in consequence of the cyst being attached to some solid substance, all the Vorticella-cysts would be transformed into *Podophryæ*, supported on longer or shorter peduncles.*

These are the real facts upon which Stein supports the doctrine of the transformation of Vorticella-cysts into *Podophryæ*. For the circumstance that in infusions containing cysts of *Vorticella microstoma*, *Podophryæ* afterwards made their appearance, can certainly not be regarded as decisive in favour of the notion which would view the two Infusoria as standing in any connection of development.

With respect to the second proposition concerning the transformation of the motile embryo into a *Vorticella*, Stein admits that he has not directly observed it, as in spite of

* Stein, 'Infusionsthiere.,' p. 145.

every endeavour he was never able to keep the embryo long enough in the field of view. "The only proof, therefore, would exist in the extraordinary resemblance of the motile embryo, in form, ciliation and movement, to the detached gemmated embryo of *Vorticella microstoma*." *

My own researches on *Podophrya* have led to the following results :

Podophrya fixa, Ehr., occurred in great abundance in an infusion containing multitudes of *Stylonychia mytilus* and *S. pustulata*. The spherical body was furnished on all sides with capitate retractile rays, and fixed on a peduncle, or free. The peduncle was enlarged on the free extremities, straight or slightly curved, and it was as long or longer than the body.

The contents of the body were in most instances more or less opaque, coarsely granular, and enclosed a round contractile space, and an oval, straight or curved nucleus; which could be perceived only in those individuals in which the contents were fluid. I could not perceive any membrane surrounding the body. Nearly every specimen of the *Stylonychiæ* was infested with one or several *Podophryæ*. In proportion as the body of the *Stylonychia* diminished in size and broke up, did the colour of the *Podophryæ* become deeper and deeper, and their size increase. In many individuals, fed in this way, a shallow circular depression might be seen surrounding the body equatorially (fig. 1). In about half an hour this annular constriction had advanced to complete transverse fission (pl. VII, figs. 2, 3). About ten minutes afterwards the upper segment had assumed an elongated form, was more cylindrical, a little indented in the middle, and rounded at each end; and at the extremities slight oscillations to the right and left could be perceived (fig. 3). A transverse and, frequently, curved nucleus was visible in the fluid contents, and a lateral contractile space could be clearly distinguished in the upper parts. The vibrations increased in frequency and force until the segment became wholly detached and escaped. During the process of division both segments were furnished with tentacles; but when the oscillations of the cylindrical portion commenced, very fine and short cilia might be seen, though with difficulty, vibrating on the free end, the tentacles at the same time being retracted, and remaining visible only on the posterior segment. I now followed uninterruptedly the movements of the liberated segments. They moved for the

* Stein, l. c., pp. 167, 168.

most part in curved lines, in the course of which the motile segment appeared to seek the illuminated side of the drop of water. Cilia could not be perceived over the whole surface (fig. 3′). The contractile space during the movements was always in front. The motions were rapid, but still such as to allow of their being followed with a magnifying power of 370 diam. After waiting patiently for twenty minutes I saw the motion cease, and at the same time short tentacles made their appearance, which were protruded more and more, and in a few minutes afterwards the segment regained the spherical form; thus, after moving about freely for a time, it was again transformed into a *Podophrya*.

This process of division was witnessed by other observers. It takes place more especially when sufficient nutriment is supplied by numerous *Stylonychiæ* to the *Podophryæ*. The *Podophrya* does not always divide into two equal halves—the segments are more frequently unequal. After repeated division the specimens always become more transparent.

If *Podophryæ* are allowed to remain for several days upon the object-glass, and care is taken not to let the water dry up, every stage towards the quiescent condition—that is to say, towards the "encysting"—may be followed.

In *Podophrya*, this process takes place in the following manner: On the surface of the body a gelatinous mucous layer appears to be secreted, through which the tentacles pass (fig. 4). The tentacles disappear in the neighbourhood of the peduncle, and the gelatinous layer in this situation hardens into a loose, transversely plicated membrane; whilst at the upper end it is still soft, and the tentacles clearly visible (fig. 5). Ultimately these also are retracted, and the entire body of the *Podophrya* is enveloped in a wide, loose membrane; the plications are caused by parallel, annular constrictions, placed at equal distances apart and separated by circular, angular or rounded ridges; these plications are in a plane perpendicular to the peduncle. At the summit of the *Podophrya*, and often also at the base, the membrane presents deep depressions (figs. 7, 6); the enclosed body of the *Podophrya* acquires on its surface a sharply defined smooth membrane; whilst the contents of the body become somewhat opaque, enclosing a round clear space (figs. 6, 7, 8). The Podophrya-cyst thus formed is supported by a peduncle, which is widened at the base. In many instances in which the membrane was not plicated, but loosely enclosed the *Podophrya* like a sac, I noticed that the peduncle of the cyst was continued uninterruptedly into the membrane, of which

consequently it must be regarded as a protrusion, and that it had no connection whatever with the original slender peduncle of the *Podophrya* itself. In fact, I noticed cysts in which this original slender peduncle was appended to the saccular envelope (fig. 8). I am unable, therefore, to adopt Stein's view that the *Podophryæ* are enclosed in a membrane, of which the slender peduncle is simply a tubular protrusion.* This is true only with respect to the short peduncle of the encysted *Podophryæ*.

What afterwards becomes of the cysts I have been unable, in spite of observations continued for months, to determine.†

Comparison of my fig. 5 with that of Stein (l. c., pl. iv, fig. 31), will remove all doubt as to their representing identical forms. These forms, as has been mentioned, are regarded by Stein as transitional stages from the Vorticella-cysts into *Podophryæ*. I have traced their derivation, step by step, in the same specimens, *from Podophryæ;* they are, most certainly, *not* metamorphosed Vorticella-cysts, but the commencement of the encysting of a *Podophrya*,—*Podophryæ*‡ are not formed out of them, but, on the contrary, from the latter arise the forms above described, which Stein looks upon as *Podophryæ* remaining at an early stage of development. The metamorphosed contents of older Vorticella-cysts, regarded by Stein as the first commencement of the formation of a *Podophrya*, indicate, according to what I have seen in other infusorial cysts,§ and to what Stein himself states, with regard to *Vorticella microstoma*, the commencement of the breaking up of the entire contents into numerous smaller "swarm"-cells.

I now proceed to show the relations of the motile embryo.

In a watch-glass in which I kept a great many specimens of *Hydra fusca* in water, numerous *Acinetæ* occurred in the mucoid deposit, which could in no respect be distinguished from those represented in Stein's figures 28, 38, 41, pl. iv. They were oval, spherical, or two- to four-lobed bodies; in the spherical forms the long slender tentacles were usually grouped in two opposite bundles; in the lobed forms often

* Stein, l. c., p. 144.

† The Podophrya-cysts have been described by Dr. Weisse under the name of *Orcula trochus*. 'Bull. de la Classe phys. math.,' t. v, No. 15; t. vi, No. 23.

‡ Sic in origine. [*Vorticellæ*?]

§ I have observed the formation of several cells in the cysts in *Stylonychia pustulata*, *S. mytilus*, and *Nassula ambigua*. In the latter, these cells constitute protrusions, and their entire contents break up into numerous, motile, monadiform corpuscles.

seated upon wart-like eminences. The contents were clear, fluid or grumous, enclosing from one to four contractile spaces. Most of these *Acinetæ* were without peduncles, and had no limitary membrane, although numerous specimens might be seen with a short peduncle and imbedded in a mucoid thick envelope; and this was especially observed when the *Acinetæ* had lived for about a week on the object-glass (figs. 9, 10). Although numerous points of relation exist between these Acineta-forms and *Podophrya fixa*, Ehr., I am, nevertheless, unable to determine whether they should be regarded as identical, or, with Stein, whether *Podophrya* and *Actinophrys* should be considered as the extreme links in the morphological cycle of one and the same species.* The peduncle of an *Acineta* is a tubular elongation of the enveloping membrane; whilst, in the membraneless *Podophrya*, it is an independent formation. When the *Podophryæ* are left in water for a few days upon the object-glass, they form the very characteristic pedunculate cysts, but under the same conditions I have never been able to follow the Acineta-forms now in question to the formation of cysts; the former multiply by division—whilst, in the *Acinetæ*, I have never noticed the occurrence of that process. What Stein describes as *Actinophrys* is really a non-pedunculate *Acineta*; the *Actinophryæ* have no tentacles, but *setæ*, though perhaps occasionally some of these setæ are capitate. In almost every specimen of the *Acinetæ* in question, might be seen rotating a round or oval embryo, of various size and position, with one or two contractile spaces (fig. 9). This embryo slowly approached the wall of the *Acineta*, caused it to protrude a little outwards, and, after remaining for a short time quiescent, it slowly made its way through the wall, and quitted the parent site with the rapidity of lightning, when it had freed about half of itself. This rapidity was so great that the course could not be traced with a magnifying power of 170 diam. (fig. 10). About five minutes elapsed from the commencement of perceptible motion to the complete liberation of the embryo; and on many occasions I saw two rotating embryos liberated in succession. When the embryo is half out of the parent-cyst, a transverse ring of very fine vibratile cilia may be perceived at a short distance from its summit. I was prevented from further pursuing this observation, which was made in June, and it was not before November that I found the same *Acinetæ*, but in far smaller numbers.

* Stein, l. c., p. 143

After waiting for a few weeks in vain, I at last noticed individuals containing rotating embryos. But the motion was very slow, and the embryo often reached the surface of the *Acineta* without its being able to make way through it, in which case it perished. The number of rotating embryos gradually increased, and their liberation, although very slow (half to three quarters of an hour), may be frequently witnessed. The half-freed embryo in these cases also moved off with extraordinary rapidity. I determined to follow the embryo in its hasty wanderings, and actually to convince myself of the supposed transformation into a *Vorticella*.

I endeavoured in the first place to retain as many full-grown specimens of *Acineta*, as possible, upon the object-glass, so as not to be interrupted by any deficiency in the number of "motile" embryos. I employed in the inquiry a simple microscope of low power. Having fixed a large *Acineta* containing a rotating embryo, I witnessed the liberation of the latter, and followed it—by moving the object-glass—step by step.

The embryo traversed the drop of water from one side to the other, in divers straight and undulating lines, as quick as lightning. Upon meeting a mass of mucus or the edge of the drop, it bounced back again—repeating the manœuvre on each occasion of the same kind; sometimes, though more rarely, the movement was circular around the margin of the drop.

Judging from what I had noticed in the division of the *Podophryæ*, I expected that the movement would not be of long duration. But after a continuous observation for fully five hours of the active motions of the tiny brilliant point, a determination of blood to the head obliged me to desist.

A fresh drop of the infusion, in which two embryos were in active motion, was observed at intervals of a quarter of an hour. At the end of five hours the rapidity of the movement was notably diminished—it became tremulous, and then perhaps for a time as rapid and energetic as before. I now placed the object under the compound microscope, and continued my observation of the indefatigable embryo for another quarter of an hour; the embryo became stationary—I awaited with drawn breath what would come next: its form from oval became spherical; at the border appeared short, thick, equidistant rays, which after awhile were developed into elongated, capitate tentacles (figs. 11, 12); the contractile space was visible—and I could not longer doubt as to the *Acineta* nature of the creature. This observation was twice repeated.

It can, therefore, no longer be doubted that from the *Acineta-embryo,* after a prolonged motile stage, another *Acineta* is formed. My observations do not, of course, show that it is impossible that the motile Acineta-embryo should be transformed into a *Vorticella,* and a *Vorticella-cyst* into an *Acineta ;* but the field of possibilities is very wide, everything is possible if it only be founded on facts. I believe, therefore, that it may justly be concluded that Stein's Acineta-doctrine, as concerns *Vorticella microstoma,* Ehr., must be regarded as *hyvothetical,* and not based upon *facts.*

VARIOUS DIMENSIONS.

Diameter of the *Podophrya fixa* . .	0·04 —0·07m.
Length of peduncle	0·025—0·05m.
Thickness of ditto	0·005m.
Length of divisional embryo . .	0·075m.
Breadth of ditto . . .	0·06m.
Diameter of the cyst . . .	0·05—0·08m.
Length of peduncle of cyst . . .	0·03m.
Thickness of same at the cyst . .	0·025m.
Diameter of enclosed globular body . .	0·05m.

NOTES AND CORRESPONDENCE.

The Infusoria.—Great uncertainty still prevails with respect to the internal organs of these forms, and from the details recently published regarding them (chiefly abroad), it appears that a more intimate knowledge of their physiology tends to show that, although not so highly organized as they were represented by Ehrenberg, they are not so simple in their internal structure as they were supposed to be by some later observers.

Under these circumstances, I may be allowed briefly to submit the chief results of my observations during the past twelve months, so far as they bear upon the subject under consideration.

Alimentary vesicles.—Having repeatedly watched the ingestion of food, both with and without adding indigo to the water in which the Infusoria were contained, I have frequently observed—1st. The alimentary particles, which are driven in by the action of the oral cilia, and are accompanied by more or less water, enter the gullet, accumulate just *beyond* its termination within the body, and there form a ball. This ball, as is well known, sinks into the body after it has attained a certain size. 2d. That the globules or balls thus formed appear fixed in *Glaucoma*, &c., and to rotate in *Nassula*, &c., as mentioned in your number of last January. But I would now add, that in the former types they also move, but so slowly, that their motion is only perceived after long and careful observation. 3d. Sometimes, when there have been but few particles of indigo, I have seen the globule formed by the admission of *water*, and *within that globule* small particles of indigo rotated rapidly so long as the process of formation continued; but as soon as the globule sank into the body, the rotation ceased. This must not be considered as a proof that the action of the oral cilia is constant and mechanical; for I have often seen *Glaucoma scintillans* with its body as clear as crystal, and perfectly free from food-globules or any vesicles, excepting the contractile vesicle. The alimentary vesicles appear to get rid of their contents gradually, the refuse passing through the anal orifice, wherever that may be situated.

Contractile vesicles.—Of the various theories that formerly existed concerning these organs, two opposite ones still

remain. By some microscopists they are regarded as portions of a water-vascular system—these observers believing that they have found an external opening communicating with the water; by others they are supposed to form a rudimentary circulating system (heart), by which the liquid produced from the digestion of food is circulated through the body; my own *present* view will be gathered from the following observations:

The contractile vesicle I have almost invariably found to be near the surface of the body.

Glaucoma scintillans is furnished with *one* central vesicle, and when that contracts, it forces the fluid into others which appear to be temporarily formed around it; these in their turn amalgamate and form the central vesicle by fusing their contents together. This, I believe, to be the whole circulation in the form named, and I do not find in this case that the surrounding vesicles have any outlets or canals as described by Lieberkühn. The central vesicle I have almost always found to be on the side furthest removed from the object-lens (the animalcule appears to move in this position), and the *auxiliary vesicles* are formed *inwards*—*i. e.*, the fluid rises *into* the body, and there forms the vesicles. This may be tested by raising the object-lens whilst the central vesicle is contracting, and depressing it when the amalgamation takes place (of the smaller vesicles). I believe that my observation in this respect is accurate, as I have frequently repeated it, and am therefore somewhat inclined to regard the contractile vesicle as a heart; that it should be near the surface is natural, and by bringing the nutritive fluid into close contact with the water, it renders the admission of that medium *into* the body unnecessary. The nutritive fluid seems to alternate between the central and surrounding vesicles.

In *Paramecium caudatum*, a species of *Amphileptus*, a freed *Vorticella*, &c. I have frequently and clearly traced the canals that empty themselves into the contractile vesicle. In the second-named species, these canals were very perceptible; they proceeded along the edge of the body where the cilia were the most active (also probably because there the current of fresh water would be constantly renewed), and at the embouchure into the central vesicle, swelled into a bulb-shape. In the *Vorticella, the contractile vesicle had a canal which communicated either with the external surface, through the oral aperture,* or passed *round* the oral wreath. I was inclined to believe the latter to be the case (perhaps my bias may have influenced the observation).

In certain Infusoria there appears to be a more active vital power than in others. Thus, in *Glaucoma*, *Vorticella*, &c., the food-balls move very slowly, whilst in more highly organized types the motion is more rapid. In the former (especially such as are probably larval forms), the contractile vesicle appears to have the power only to form a row of auxiliary vesicles around it; whilst in *Amphileptus* (which approaches the Planarians in its character), the Setifera or bristle-bearers, and other types, it is more powerful, and the fluid is ejected with sufficient force to work its way into the body, and form canals, or arteries, however primitive they may be. The progressive vitality I have often noticed in the same form at different stages of its growth.

The foregoing remarks are not made for the purpose of pushing forward my own views and opinions, for these must necessarily become changed or modified as the science progresses; but with a view to direct observation to the subject, and obtain for it a greater share of the attention of English microscopists than has hitherto been bestowed upon it.—JAMES SAMUELSON.

When are Diatoms common in a Slide?—All who have received gatherings of diatoms have been frequently puzzled by the observations which accompanied them in regard to the scarcity or abundance of a particular species; and it appears to me that some law on the subject would be of essential service, and might save many from disappointment. Unless it be mentioned that the species sought is only to be met with in the heavier or lighter portions, it is understood that the average is intended, as obtained by shaking the little tube in which the preparation or "boiling" is kept; and with that understanding, the following observations will indicate the principles on which more definite terms may be founded.

Dr. Gregory, in last number of the 'Micr. Soc. Trans.,' enumerates 304 species found in the Glenshira Sand, of which, however, a few appear not to be diatoms; some supposed new, seem (if one may judge from the descriptions and figures) to be only varieties of well-known species, and others are of that extreme scarcity as not to form $\frac{1}{1000}$ *per cent.* of the preparation, and therefore are to be seen in few of the slides; on no one slide can there be said to be 200 species. Again, according to Smith's Synopsis of Diatomaceæ, there appear to about 500 species in Great Britain; as nearly one half of these are marine, the rest from fresh

water, and as we cannot expect all of each sort to be present in a gathering, the above number (200) is an ample allowance, and I myself have never seen so many in a slide.

Assuming this to be the probable number, each species ought to occupy a space equivalent to the $\frac{1}{200}$th part of the area allowed for diatoms, or portion protected by the cover. As the specimens should not be crowded, I hope that I make a liberal allowance for a vacancy, when I ask only the $\frac{1}{500}$th part of the whole area to be devoted to any one species, in order that it may have as much space allotted to it as to the others; when, therefore, it occupies the $\frac{1}{500}$th part, it ought to be called neither "common" nor "rare." To this line there may be allowed a margin, so I propose that when a species occupies from the $\frac{1}{200}$th to the $\frac{1}{1000}$th part, it may be denominated as above; and this may be conveniently divided into those which occupy from the $\frac{1}{200}$th to the $\frac{1}{500}$th, and from the $\frac{1}{500}$th to the $\frac{1}{1000}$th part; the former receiving the name of "not common," the latter of "not rare." In the same way from $\frac{1}{40}$th to $\frac{1}{200}$th may be called "common," and from $\frac{1}{1000}$th to $\frac{1}{5000}$th "rare;" beyond these extremes, on either side, we have "very common," and "very rare."

To apply this: If the cover be about half an inch = ·5 in diameter, the area of diatoms is $\cdot 5 \times \cdot 5 \times \cdot 7854 = \cdot 2$ nearly; in which case, if a species does *not* occupy $\frac{\cdot 2}{5000} = \cdot 00004$, it is "very rare;" from that to ·0002 "rare;" from that to ·0004 "not rare," from that to ·001 "not common," from which to ·005 "common," and if more copious, "very common." In measuring any diatom, it is sufficient to multiply together the length and greatest breadth, allowing the vacancy caused by its not having a rectilinear figure to be added to the vacancy already mentioned. If we now take *Campylodiscus costatus*, its length and breadth in the untwisted state is about ·003, and its surface, got in the way just alluded to, ·00001 nearly; hence dividing by this number, we get less than 4 frustules when "very rare" (*v.r.*), in a slide, from 4 to 20 when "rare" (*r.*), from 20 to 50 when "not rare" (*n.r.*), 50 to 100 when "not common" (*n.c.*), and from 100 to 500 when "common" (*c.*) In *Eunotia tetraodon*, the average length is about ·002, and breadth ·001, and surface ·000002; hence, when there are not $\frac{\cdot 00004}{\cdot 000002} = 20$ under a cover half an inch in diameter, it is "very rare," from 20 to 100 "rare," and so on. In *Navicula cryptocephala*, the average surface is $\cdot 0011 \times \cdot 00035 = \cdot 0000004$ nearly; so when there are

not $\frac{\cdot 00004}{\cdot 0000004} = 100$ in the slide, it must be accounted "very rare;" above 100, but not exceeding 500, "rare" only, this giving almost one to every field of a "$\frac{1}{4}$" object-glass.

And this leads me to observe that when the specimens are small, or so numerous that they are entitled to be called "common," they ought to be seen in every field of a "$\frac{1}{4}$" object-glass; and then we may decide on the appellation to be given by counting those observed in the field at one time, or by taking an average of two or three fields. The object-glass I employ has, with a low eye-piece, a field of ·02 inch in diameter, and therefore an area of about ·0003 nearly; hence to be "not common," each species ought to occupy from $\frac{\cdot 0003}{500}$ to $\frac{\cdot 0003}{200}$, that is from ·0000006 to ·0000015; and to be "common" from ·0000015 to ·0000075. In the case of *Campylodiscus costatus* already mentioned, its area is ·00001; and as the greatest of these numbers (·0000075), divided by ·00001, only gives ·75 or $\frac{3}{4}$, only three specimens may be expected in four fields of view; and therefore, although one only occurs in every field, the species ought to be esteemed "very common." In *Eunotia tetraodon*, the surface is ·000002; hence, when there are from one to four in the field at once, it may be called "common," more than that "very common." *Navicula cryptocephala* has a surface of ·0000004; and as $\frac{\cdot 0000006}{\cdot 0000004} = \frac{3}{2}$; so, unless are there at least three specimens to every two fields of view, the species must be held as only "not rare," if, indeed, it be not "rare," or "very rare," when we must have recourse to the area of the cover.

A very slight practice will render the actual calculation unnecessary; but there ought to be some check, for many slides sold are almost worthless, from not containing specimens of the species labelled, and for which it is purchased, in a sufficient number to illustrate its variations.—A.

The Microscope as a means of Diagnosis.—*Singular case of Intestinal Concretions.*—The value of the microscope as a means of diagnosis is now universally acknowledged by every medical man. Many are the instances I could enumerate, in which, without its assistance, no clear or definite opinion could be arrived at. Among the many cases which have come under my observation, the following one may not be uninteresting, as I know of no other similar case, save one mentioned by our esteemed friend, Mr. Quekett, in his first volume on 'Histology.' I give you the history of the case

as detailed to me by Dr. Wilkinson, of Manchester, under whose care the patient was placed, and to whose kindness I am indebted for the account.

R. L—, aged 52 years, a power-loom weaver, has never been the subject of any ailment until four years ago; in fact, he does not remember ever having had a day's illness. At that time he suffered slightly from indigestion, felt some uneasiness at the pit of the stomach, with at times, though rarely, actual pain. The food taken frequently returned at intervals, varying from ten minutes to two or even four hours after ingestion. The vomit, if retained for some hours, presented the appearance of butter-milk and treacle. He never vomited except when the stomach contained food; but he was subject to frequent eructations of a small quantity of clear fluid, intensely acid; sufficiently so to set the teeth on edge, and to produce even a shudder at the recollection. About this time he perceived a hard body directly below the ensiform cartilage, but somewhat to the right side, lying as it were between the depending point of the cartilage and the right costal cartilages. He judged that the lump he felt was a hard substance about the size of a hen's egg. He felt this lump pass down along the course of the duodenum and intestines, until it arrived in the left hypochondriac region. A short time after this it was passed by stool, being several weeks after he had first noticed it. The whole of the time he had severe and continued pain; and after it had passed, per rectum, he suffered for thirteen hours severely. Sixteen days afterwards another concretion was passed; and at the end of sixteen days more one still larger. There were no other concretions passed for two years, and then another of a smaller size.

He then felt a hard tumour in the abdomen on the right of the umbilicus which has since gradually increased; continuing hard, moveable, and somewhat changes its position, but does not seem to move along the canal.

The concretions which have been passed have not varied greatly in appearance being irregularly oval. The one he presents is hexagonal, apparently presenting articular facets of a lightish brown colour.

He states that he has lived since childhood principally on oatmeal porridge with treacle, has taken little animal food; and, during the four years he has been unwell, has taken magnesia as a purgative. He, however, says that he took no magnesia before the first concretion was passed.

Such is the case as sent me by my friend with a portion of the concretion for microscopic analysis. Chemistry and

all other means had failed to unravel the mystery of the composition of this concretion. I macerated a portion of it for some time in distilled water, expecting to detect the starch granules of the oat by the polarizing apparatus of the microscope, but in this I failed. I continued the maceration, separating the parts a little with very fine needles,

and at last was able to detect very beautifully masses of the hairs of the palea of the oat, of which, and the husks of the oat, the concretion seemed to be entirely made up.

I need say no more, the value of the microscope in this case is undeniable; and I have only to present you with a slide and a drawing of the analysis for your own inspection. —H. Munroe, M.D., Hull.

On Microscopic Apparatus.—Allow me to call your attention, and that of your readers, to two little contrivances of mine, as they may be found useful.

The first is a simple apparatus for illuminating objects under the microscope; and will be found particularly of use when examining Diatomaceæ. Knowing that there are many microscopical observers like myself, not able to expend large sums in accessory apparatus to the microscope, I particularly recommend it to their notice.

It consists of a plate of glass (s, fig. 1) (an ordinary slider), three inches by one; to one side of which, in the centre, is attached, by Canada balsam, a *plano-convex* lens (l), and this may be of about one quarter-inch focus. Lenses of different powers can be used, although I have found one of half-inch and one of a quarter-inch focus to be the most useful. The way in which this is used is seen in the first figure. The rays of light (r) fall on the lens (l), placed on the microscope-stage (k), so that the flat side is uppermost, upon which is

placed the object to be examined. The rays are brought to a focus (F), at some distance above the object (O), thus giving an even white light over the whole field of vision, and this I have found particularly advantageous when using low powers

Fig. 1.

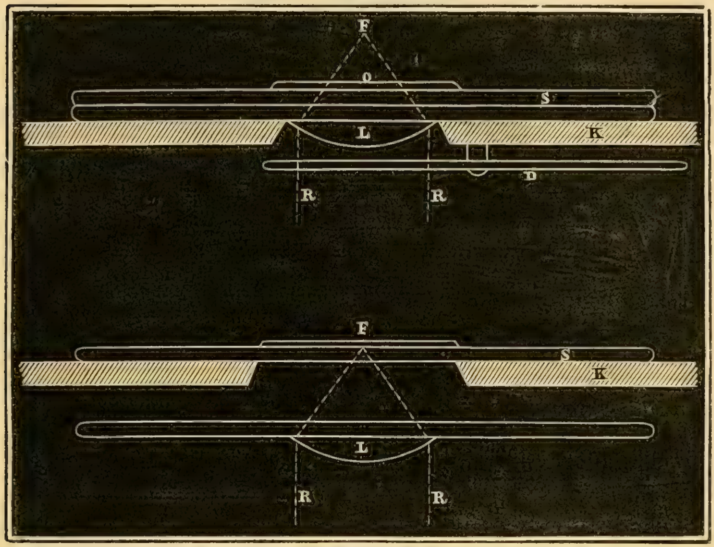


Fig. 2.

for viewing objects. We can modify this arrangement by placing the lens below the stage (as in fig. 2), and at a point where it can be adjusted by a rack and pinion, so that the rays from it are focussed on the object. However, the first arrangement I have found the most generally useful. To this can be added a diaphragm (fig. 3), which any one can make for himself, to fit the microscope, of blackened card-board. The general utility and cheapness of this simple contrivance will, I think, recommend it to the considera-tion of all whose purses are not as large as their desire for knowledge.

I should also mention that I have found this illuminator particularly useful on dull days, when, by the mirror alone, only a gray light could be obtained, while, with the addi-tion of my condensing lens a clear white light is obtained; and, from the reason of most of the rays falling obliquely on the object, the markings of certain of the Diatomaceæ can be easily resolved with it. When the diaphragm (fig. 3) is

added, with its numerous apertures, and which can be varied to suit the fancy, we get an apparatus which, on important occasions, will be found to fill the place of the more expensive achromatic condenser.

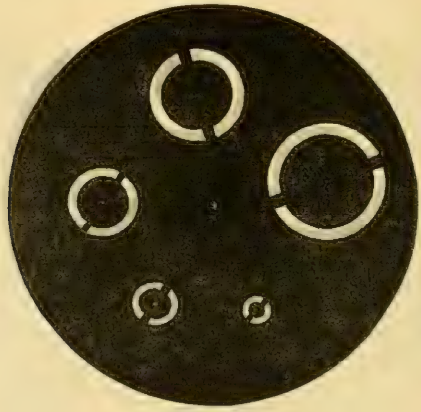


Fig. 3.

The second contrivance of which I have to speak is a clasp to hold bottles at the end of the rod with which the searcher for minute organisms is provided. Many microscopists have found the ordinary contrivances, for this pur-

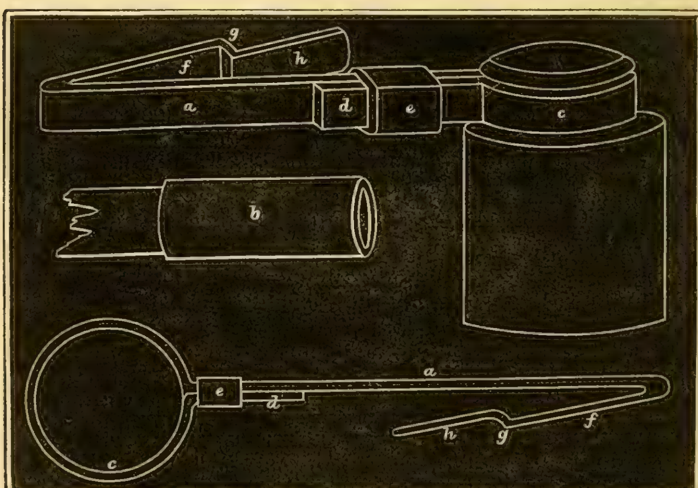


Fig. 4.

pose, troublesome or requiring fine workmanship; and have been led to invent more simple ones for their own use—thus has it been with me.

My clasp consists of a strip of sheet-brass (*a*, fig. 4), ten inches by one half of an inch, and about as thick as stout Bristol board; indeed, so thick that it will bear the weight of a two-ounce bottle without bending. This is bent, as is seen in the figure (4), and around it is wrapped another piece of brass, so loosely that it will slide upon it. To the end of the rod which is used for the purpose, is attached a brass tube (*b*), the end of which is slightly turned over, inwards. The bottle is now placed in the loop (*c*), and the end (*d*) being brought down on *a*, the slide (*e*) is pushed up so that it holds and clasps the bottle firmly. The spring part (*f*) is now forced into the ferule (*b*), until the catch (*g*) holds it in its place. When it is wished to remove it, we have but to press the spring-catch at *h*, and it can easily be taken out of the ferule.

I offer these remarks with much readiness, and shall be pleased if you deem them worthy an insertion in your valuable periodical.—Arthur M. Edwards, College of Physicians and Surgeons, New York City, U.S., October 20th, 1856.

PROCEEDINGS OF SOCIETIES.

Microscopical Society, *September 29th*, 1856.

George Shadbolt, Esq., President, in the chair.

A short Communication from the Rev. S. G. Osborne, being a continuation of his Paper "On the Growth of the Wheat Plant," was read.

A Paper, by J. S. Bowerbank, Esq., "On the Structure and Vitality of the *Spongiadæ*," was read.

November 26th, 1856.

George Shadbolt, Esq., President, in the chair.

J. Brand, Esq., 36, Nicholas Lane; Jas. Hopgood, Esq., Clapham Common; Dr. T. H. Barker, Bedford; Dr. Shearman, Rotherham; John Anderson, Esq., 4, Bedford Terrace, Clapham Rise; and E. C. Hulme, Esq., 19, Gower Street, were balloted for, and duly elected members of the Society.

Dr. Lankester made some remarks explanatory of the Rev. S. G. Osborne's views respecting the Growth of Plants.

December 10th, 1856.

George Shadbolt, Esq., President, in the chair.

Charles May, Esq., H. C. Rothery, Esq., Dr. Donkin, John Loxley, and Dr. Ladd, were balloted for, and duly elected members of the Society.

A discussion on the expediency of introducing one uniform Screw for Object-Glasses, took place.

ORIGINAL COMMUNICATIONS.

On some points in the Structure *and* Physiology *of certain* Fungi, *with notices of the occurrence of some species new to this country.* By Frederick Currey, Esq., M.A., F.L.S.

The object of the present communication is sufficiently described in the title given above. Being the result of a number of observations made at various times, the paper may appear to some extent discursive and unconnected, but I venture to hope that the facts recorded will be considered of some scientific value. Such of the subjects as required illustrations to render the discussion of them intelligible, are figured in the accompanying plate from drawings made (with the exception of figs. 42, 43) with the Camera lucida.

Helminthosporium Smithii. (B. and Br., 'Annals and Mag. of Nat. Hist.,' s. 2, vol. vii, pl. v, fig. 5.)—On holly, Chiselhurst, Kent, September, 1855. This is a magnificent species, and has been well characterised as the prince of the genus. It is described at length in the volume above referred to, and I notice it only with the view of recording some observations on the form and mode of germination of the spores. In the figure in the 'Annals of Natural History' the endochromes are closely united, but it is stated in the text that they are here and there surrounded by a broad cavity. Figs. 1 and 2, Pl. VIII, represent two of the spores of my specimens, magnified 220 diameters; they vary much in size; and the latter figure will give an idea of the enormous length which these spores attain. It will be seen that the endochromes vary in their degree of approximation to each other, but that each one is quite separate from its neighbour, and this was the case in all the spores which I examined. Germination takes place by the protrusion of a colourless filament from each extremity of the spore, which filament very soon forms septa in its interior, and throws out lateral branches. There is nothing more in this than has been observed in many other fungi, but it is interesting to notice that precisely the same process took place when a spore was broken into fragments. Figs. 3 and 4 represent two detached pieces of spores, which have thrown out filaments from each of their extremities, and commenced growing, just in the same way as the perfect spore. This seems to show that each portion of the endochrome has an independent power of germination, and if so it is

difficult to see in what way the spore in this case differs from an ascus, for although the spores which are produced in asci usually escape and become free before commencing germination, the contrary is by no means uncommon. I did not see any germination except from the extremities of the spores, but it is very possible that in their natural condition germs may be thrown out from the intermediate endochromes, or the whole coat of the spore may dissolve and set the separate endochromes free. What is perhaps more singular even than the germination of the fragments of the spores, is the fact that the same thing takes place with the fragments of the flocci. Fig. 5 shows two such fragments, in which processes, precisely similar to the germ-filaments of the spores, have been protruded from each extremity. It is easy to distinguish the fragments of flocci from the spores, the former having real septa, which are not to be found in the latter. The septate appearance which, according to the figure in the 'Annals of Natural History,' exists sometimes in the spores of this species, would be produced by the contact of the endochromes, and not by the existence of real partitions. It is very important, in describing the spores of fungi generally, to distinguish between real septa and those which are only apparent.

Helminthosporium fumosum. (*Dactylium fumosum*, Corda, 'Flore illustrée de Mucedinées d'Europe,' pl. xxii.)*—This interesting addition to the British Helminthosporia occurred in the neighbourhood of Blackheath, upon the dead stem of some Umbelliferous plant. It was first described by Corda in the work above mentioned, under the name of *Dactylium fumosum*, but it clearly belongs to Helminthosporium, and has no affinity with Dactylium. The flocci are stiff and erect, and, when ripe, of a very dark brown or almost black colour, being so opaque that it is a matter of difficulty to make out that they are septate. At the apices of the flocci there originate several rows of almost colourless cells, arranged in a moniliform manner, and spreading in different directions. The spores are attached in rows at the extremities of the chains of colourless cells, and are of a rich brown colour, usually somewhat narrowed at each end, and divided by several transverse lines having the appearance of septa, but which I believe to be only lines formed by the mutual pressure of the divisions of the endochromes. Fig. 6 represents three spores joined together, magnified 220

* This is the same work as the 'Prachtflora Europäischer Schimmelbildungen.' It was published both in French and German

diameters. Corda mentions the decaying stems of Umbellifers as the habitat of the plant, but adds that it sometimes grows on patches of *Torula punctata* and *Torula herbarum*. It is hardly distinguishable from *Torula herbarum* by the naked eye, but the latter has a greenish tinge under a lens which can hardly be mistaken. There were a very few spores of the latter Torula in company with my specimens of the Helminthosporium.

Botryosporium pulchrum. (Corda, l. c., pl. xix.)—This mould forms large white mealy patches upon dead or living plants, upon annuals by preference, according to Corda. I found it upon a fragment of some herbaceous plant in a rubbish heap at East Bergholt, in Suffolk, in the month of October, 1854. The flocci are very delicate, forming a woolly-looking mass, and the spores are arranged in four or five compact globular masses at the extremities of short ramuli, which are alternate upon the main threads. Corda's figure is very good, but I have not seen the tubercles upon the main flocci, to which, according to his statement, the lateral branches are articulated.

Phragmidium.—Notwithstanding the number of observations upon the Phragmidia which have been made and published from time to time, there are points connected with their anatomy and physiology upon which differences of opinion exist, and which render the genus one of especial interest to the microscopical observer. In the first place, the question of the relationship between the Phragmidia and the Uredo, with which they are almost invariably associated, can hardly be considered to be finally decided. All mycologists, I should suppose, would admit that both kinds of fruit belong to the same plant, *i. e.*, are the produce of the same Mycelium, but it seems to me to be still an open question, whether the Phragmidia represent a highly developed state of the grains of the Uredo, or whether the two productions are essentially distinct forms of fruit. M. Tulasne, in his memoir in the 'Annales des Sciences' for 1854, merely states his accordance with Unger's opinion that the transformation of the Uredo-grains into Phragmidia is inadmissible; but it cannot be denied that when a number of these fruits are mixed together it is sometimes hardly possible to say to which sort one particular specimen belongs, so delicate are the gradations by which the one kind passes into the other.*

Another question which would admit of discussion is that

* In the 'Botanische Zeitung,' 1853, p. 787, Itzigsohn suggests that the Uredo-grains are produced from the interior of the Phragmidia, an opinion which I cannot reconcile with my own observations.

of the generic distinction between Phragmidium and the allied genera Puccinia, Uromyces, Triphragmium, and Xenodochus. The number of divisions or apparent divisions of the spore affords no safe criterion, for it is not uncommon to find Phragmidium and Puccinia reduced to a single dissepiment, and the reniform shape of the so-called sporidia, which are produced by the germinating filaments of the latter, and which Tulasne mentions as a distinguishing characteristic, is not constant, as I have myself witnessed. The fruit of Phragmidium, moreover, sometimes assumes a form quite similar to Triphragmium. There is a species of Triphragnium (*T. deglubens*, Berk. and Curt.) in which the dissepiments are arranged precisely as in Phragmidium. The number of the pores through which the germinating filaments make their exit has been advanced as another ground of distinction between these genera; but here, again, there is no sufficient certainty, for Phragmidium has a variable number, and the rest have only one. These pores, moreover, are frequently, I may say usually, not discernible in the natural condition of the fruit, and only become visible upon the application of some chemical agent, which renders the epispore more transparent.

It is quite impossible to arrive at any correct notion of the anatomy of Phragmidium by examination with the microscope alone, for the fruit in its natural condition is far too opaque to admit of its structure being ascertained by inspection. The idea of the fruit consisting of sporidia united together and forming a chain is certainly not in accordance with the true structure, which will be found to approach more nearly to that of the ascigerous fungi than any other tribe. The sporidia are not united to one another in any way, but, although closely packed for want of space, they are in fact *free* in the interior of what may be called a sporangium or ascus. Perhaps the term sporidia is hardly applicable to the bodies in question, but, before discussing this point, it will be better to show what the structure of the fruit is, and the mode of ascertaining it—and the best method I find to be as follows.*

A considerable number of the spores of the Phragmidium must be scraped off with a lancet or fine-pointed knife, care being taken to scrape gently, so as to avoid tearing off the tissue of the leaf, which would interfere with the observation.

* The term "sporidia" was originally applied to the apparent *joints* of the fruit; and some confusion has been introduced by the application of the same term by Tulasne to the globular orange-coloured bodies produced in the early stage of germination, and which are noticed hereafter.

The spores must be placed on a common glass slide in a drop of alcohol, so as to drive away the air, which otherwise clings pertinaciously to the mass of spores. Before the alcohol has quite evaporated, two or three drops of strong nitric acid must be added, a piece of thin glass must be placed over the spores, and the slide should then be gradually warmed over a spirit lamp. The acid must not be allowed to boil, at least not for any length of time, because the action then becomes so powerful as to obliterate the structures which it is wished to exhibit. By following this process it will be seen that the fruit consists of an outer colourless membrane, almost transparent, which in most of the species is studded over with small tubercles, being prominences of the membrane itself. This membrane encloses a number of cells, being the cells constituting the apparent joints of the fruit, and which in their natural state are of a squarish or oblong shape, occasioned by their mutual pressure. Fig. 15 (Pl. VIII) represents a spore which has been acted on by the acid, but not to a sufficient extent to dissolve or rupture the outer membrane; which, however, has swollen and become loosened from the inner cells. When by the action of the acid the outer hyaline membrane is ruptured or dissolved, these cells escape, become detached from one another, and assume the shape shown in figs. 7 and 8.

They exhibit a broad brownish or yellow ring surrounding a central area of paler colour, and in the interior of each of these areas is to be seen, what for distinction may be called an inner cell, which in its normal form is globular, but which frequently assumes an irregular shape. Fig. 8 represents a ringed cell with its inner cell filling the whole of the cavity, and fig. 7 shows a ringed cell with an inner cell of irregular shape. I have not yet been able quite to satisfy myself as to the structure of the ringed cells. It appears at first sight as if the ring were an integral part of the cell itself, so that if the observer be supposed to be looking upon the pole of the cell, the ring would form a mass of bulging matter at its equator; but opposed to this is the fact that under the action of the nitric acid the ring sometimes entirely disappears, leaving a pellucid, globular, colourless cell, having the inner cell in its interior as shown in figs. 9 and 10. The ring is sometimes marked with concentric lines having the appearance of wrinkles in the membrane.

Fig. 11 represents an inner cell quite free, exhibiting its granular contents and a central nucleus. The inner cells have far greater power of resisting the action of the acid than the sporangial membrane or the ringed cells, for if the acid be over-

heated the membrane and the ringed cells entirely disappear, leaving only the inner secondary cells, which when free are usually globular, as shown in fig. 11. These latter cells are colourless and of a granular aspect, but have a clearly distinct membrane of their own, and are not merely the coagulated contents of the cells within which they are produced. They become of an intense brown colour upon the application of solution of iodine. Before using the above process I had ascertained the existence of these internal cells by soaking the spores in hydrochloric acid and pressing the thin glass cover, which resulted in the fracture of the coats of both the sporangium and the ringed cell, and the escape of the inner cell, as shown in fig. 13. In many of the fruits upon which the hydrochloric acid had been left to act without pressure, the pores became extended into broad circular cavities, and the inner cell protruded itself in the manner shown in fig. 14, producing an appearance which at first sight might be taken for germination.

From the above description it will, I think, be seen that the fruit of Phragmidium hardly differs from that of the ascigerous fungi. Perhaps a closer resemblance might be found in the abnormal fruits of some of the Coniomycetes, such as Hendersonia, Steganosporium, or Prosthemium, but there is little doubt that these latter fruits are themselves only modified forms of the asci of well-known fungi of a higher class. It may be as well to state, that the outer membrane spoken of above usually dissolves altogether under the action of the acid, or breaks up into fragments, which adhere to the ringed cells after their escape; but if a sufficient number of observations be made, and under different degrees of heat of the acid, some specimens will be found in which the internal cells have escaped, leaving nothing behind but the transparent outer membrane in the form of an empty sac.

The structure of the pedicel of the fruit requires a passing notice. In the 'Botanische Zeitung' for 1853, Fresenius, in criticising some figures in the 'Handbuch der Allgemeinen Mycologie,' ridicules Bonorden for speaking of a "Saft-Zelle," in the interior of the pedicel, and leaves it to be implied that such a cell exists only in Bonorden's imagination. It is strange that so accurate an observer as Fresenius should have fallen into such a mistake, for the existence of the internal cell may be demonstrated without the least difficulty by merely soaking the spores in water. Figs. 16 and 17 represent specimens of *Phragmidium bulbosum* and *Phragmidium mucronatum* treated in that manner, in which the outer membrane of the pedicel has given way,

disclosing the internal cell in the clearest manner possible. Corda, too, has figured the internal cell in his 'Icones Fungorum,' vol. iv, pl. v, fig. 70, 6 *k*; he calls it "Mark-Zelle."

The germination of the spores of Phragmidium, Puccinia, and Triphragmium, is well worth some trouble to witness. I know no microscopical objects of greater beauty than a number of fruits of Phragmidium in active germination. Tulasne was the first to call attention to it, and I am not aware that any subsequent observations have been published. I have myself seen the process in a few species, the particulars of some of which may be worth mentioning. I found (as was previously observed by Tulasne) that the fruits of Phragmidium and Triphragmium would not germinate in the summer in which they were produced, but I think further observations are necessary before it can be assumed that this is invariably the case. If, however, the fruit be taken from leaves which have either lived, or fallen and lain on the ground, through the winter, and be placed in water and kept in a moist atmosphere, there is no difficulty in producing germination. Long tubular filaments are produced from the different cells, which attain a length of four or five times that of the fruit. These filaments have a small quantity of granular orange-coloured matter, which usually accumulates towards the extremity. At the end of these filaments septa are found, varying in number, but not exceeding four, and dividing the extremity into as many small joints, each of which protrudes a small spicule or sterigma, the apex of which expands into a globular cell, into which the orange-coloured endochrome passes. These globular cells (which Tulasne calls sporidia) eventually fall off, and commence germination on their own account. Figs. 18 and 19 represent two fruits of *Phragmidium bulbosum*, the germ-filaments of which have already produced their sporidia. Two of them have each produced two sporidia, one of them has produced three, and the other four. These sporidia are of a brilliant glittering orange colour, which, contrasted with the transparent filaments and the rich dark brown of the fruit itself, produce a combination of colour which is very striking. Fig. 20 represents a sporidium which has fallen off, and commenced germination by throwing out two filaments, one of which exhibits lateral protrusions which seem to be the commencement of branches.

With regard to the germination of the Pucciniæ, which in substance is very similar to that of Phragmidium, I have noticed two instances of departure from what Tulasne considers to be the rule. I understand his opinion to be that

the sporidia of Puccinia are always distinguishable from those of Phragmidium by their reniform shape, and that the germ-filament of the upper cell of Puccinia always makes its way out through the apex of the fruit; but I have seen *Puccinia graminis* produce globular sporidia as shown in fig. 21, and I have seen the germ-filament of the upper cell of *Puccinia Lychnidearum* make its way out at the side of the upper cell, as shown in fig. 22, instead of through its apex.

The germination of Triphragmium is described by Tulasne as precisely similar to that of Phragmidium, but in the only instance in which I have succeeded in procuring germination in the former plant it took place in a manner somewhat different, and which I have drawn in fig. 23. The filament grew to a considerable length, and formed four septa at its extremity; no sterigmata or sporidia were produced, but the orange-coloured endochrome became accumulated in each of the four terminal cells in the form of two globular masses, as shown in fig. 23. One of the four terminal oblong joints fell off, and commenced germination, as shown in fig. 24, and it was obvious that the remaining three joints were on the point of becoming separated from one another.

In illustration of the gradation from the fruit of Uredo to that of Phragmidium, and of the close resemblance between Phragmidium and its allied genera, I would here call attention to figs. 25 to 33; they all represent different forms which I found in the fruit of the same specimens of *Phragmidium potentillæ*. Fig. 25 represents the normal form of the Uredo; figs. 26 and 27 show the commencement of the formation of a division which becomes complete in fig. 28. Fig. 29 is quite undistinguishable from an Uromyces, as is fig. 30 from a Puccinia, and figs. 31 and 32 might well be taken for fruits of Triphragmium, and if seen apart from the others could not be named with certainty. Although the fruit of Triphragmium has usually only three divisions, it is by no means uncommon to find four. Fig. 33 shows the perfect normal form of fruit of this species of Phragmidium.

In the fruits represented by figs. 25 to 28 the colour was the bright orange of the Uredo; in the rest, the colour was the usual dark brown of the Phragmidium. I may here observe that the spines or prominences seen in the Uredines which accompany the Pucciniæ, and which have been advanced as a mark of distinction between the two kinds of fruit, exist, I believe, only on the surface of the endosporium. I have frequently noticed that these Uredo grains, although at first sight truly echinulate, are surrounded on the exterior by an extremely delicate and perfectly smooth membrane.

This membrane is not visible unless the edge of the spore be exactly in focus. Mr. Busk, without my having called his attention to it, noticed the existence of this membrane in some spores of the Uredo of *Puccinia pulverulenta* which I sent to him, and thought that he could perceive a slight blue tinge in it upon the application of iodine and sulphuric acid.

Xenodochus carbonarius, Schlecht.—This plant, first observed by Schlechtendal, and described by him in the 'Linnæa,' vol. i, p. 237, pl. iii, is mentioned in the 'Annals of Natural History' to have been found by Mr. Churchill Babington, in Leicestershire, and I have received specimens of it from the Rev. A. Bloxam, but it seems to be of rather uncommon occurrence. It has been found only on the leaves of *Sanguisorba officinalis*, and was formerly supposed to be parasitical upon *Uredo miniata*, in company with which it grows. There can be little doubt that the Uredo, like those of Phragmidium, Puccinia, &c., is the produce of the same Mycelium as the Xenodochus itself. The fruit forms little black tufts, which differ in no respect to the naked eye from the tufts of Phragmidium. One of these fruits, in its natural state, is represented in fig. 34, magnified 220 diameters. If treated in the manner mentioned above, with regard to Phragmidium, it will be found that their structure differs in no respect from those of the latter plant. It will be seen that each consists of a clear outer membrane, enclosing a multitude of ringed cells, each of which latter cells has another cell in its interior, which under the action of the acid is set free, and exhibits a well-defined, circular nucleus. There is, in fact, no difference between Phragmidium and Xenodochus, excepting the number of the ringed cells of the latter, unless there be a difference in the number of the pores, which, however, would be a very unsatisfactory ground of generic distinction. In fig. 34 is seen a bead-like row of cells proceeding from one of the upper joints of the Xenodochus, and which appeared after the fruit had been kept in water for some hours. I do not suppose this to be the normal mode of germination of Xenodochus, for it is hardly likely that its germination should differ materially from that of Phragmidium, Puccinia, and Triphragmium. Small cells of the nature of those forming the beads in fig. 34 are sometimes given out by the spores of fungi, and the process is perhaps analogous to that which takes place in some of the lower fresh-water Algæ. In some spores of Spirogyra, for instance, which I gathered in the month of March last year (1856), and kept by me to watch their germination, although many of them, when the proper time arrived, became green and threw out their regular germs, there were many in which the contents became trans-

formed into small, globular, colourless cells; and I have seen the contents of one of the large orange-coloured spores of *Volvox aureus* become transformed into six rather large, globular, colourless cells, which floated about in a mass of coloured endochrome, being the remains of the contents of the parent-cell. In fig. 46 I have drawn a spore of *Sphæria amblyospora,* which I observed to throw out a number of these small cells into its own gelatinous envelope, whilst the regular mode of germination in this Sphæria takes place by the emission of long branched filaments, very similar to that of its ally, *Steganosporium cellulosum,* figured in vol. iv of this Journal, Pl. XI.

Gymnosporium (*arundinis?* Corda).—I am doubtful whether the plant here referred to is Corda's *Gymnosporium arundinis.* It forms small black spots on the stems and leaves of *Phragmites communis,* and is of very common occurrence, although not, I think, described amongst the British Fungi. It is possible that it may be only an imperfect state of some ascigerous fungus, but I mention it here for the purpose of calling attention to its germination. Fig. 35 will show the manner in which the spore opens by the swelling of the inner membrane. The epispore bursts, and is sometimes carried out on each side, as in figs. 35 and 36, or it bursts on one side only, as in fig. 37, where it has the appearance of a bivalve shell opening on a hinge. The protrusion of the germ-filaments was accompanied by the emission of minute staff-shaped bodies, such as are represented in figs. 35, 36, and 37. It may perhaps be objected that these bodies were not connected with the fungus, but were developed in the water in which the spores were placed, and I was at first doubtful whether this was so; but their position with regard to the germinating spores, the very short time in which they made their appearance, and the fact of their having occurred in several other instances (to one of which I shall call attention presently) in the immediate neighbourhood of germinating spores, and their non-appearance in water containing spores in which no germination has taken place, are facts which lead me to think that the bodies in question are connected with germination, and I have therefore thought it worth while to mention their occurrence with the view of directing the attention of other observers to a fact which may be of physiological importance.*

Peziza aurantia, Pers.—In this very common Peziza, I have noticed what I take to be a kind of germination, and

* In one or two instances I have seen a distinct wriggling motion in these small bodies, quite different from Brownian motion.

which is probably of the same nature as that observed by Tulasne in *Bulgaria sarcoides, Peziza bolaris, Peziza Cylichnium, Peziza tuberosa,* and *Peziza vesiculosa.* It consists in the formation of minute spherical or subspherical utricles on the surface of the spore, and which Tulasne has called sporogenous spermatia. The bodies observed by Tulasne were sometimes (in *Bulgaria sarcoides,* for instance) upon the exposed endosporium, sometimes upon short tubular appendices; sometimes they had very short pedicels, and sometimes they were sessile; they were sometimes joined together in rows, sometimes in bunches, but were more frequently solitary, and they were often produced successively, *i. e.,* as one of them dropped off another supplied its place, until the power of the spore was exhausted. In the spores of *Peziza aurantia,* to which I have referred, similar utricles were produced, but they were all sessile upon the surface of the *inner membrane* of the spore, and in many of the spores the outer membrane (although extremely thin and fine, and easily to be overlooked) was sufficiently discernible upon a careful examination, entirely enclosing the utricles. In fig. 39 are shown three of the spores of *Peziza aurantia* in their usual form, as they appear in the interior of the asci, magnified 315 diameters; and fig. 38 shows three of the same spores after they have escaped from the asci, and lain some time upon the surface of the hymenium, and commenced the process above-mentioned. In some cases, the growth had taken place before the escape of the spores from the asci. In some of the spores, the utricles produced at one extremity or pole were somewhat longer than those in the other positions. The spores of *Peziza aurantia,* as of those of several allied species, are elliptical, and there are almost invariably found two globular nuclei, or oil drops, of equal size, occupying the two foci of the ellipse. In those spores in which the above growth had taken place, the nuclei were less distinct than in those in which no change had occurred, and in some instances the two nuclei had broken up into several; the spores also had increased in size. This is just what Tulasne noticed in *Peziza vesiculosa,* for he states that in that plant the spores which produced a Mycelium, as well as those which he calls the spermatophorous spores, increased in size sensibly before vegetating, and that their oily contents lost at the same time their homogeneity and assumed a granular aspect. There was another remarkable circumstance connected with this change of form and germination in the spores of *Peziza aurantia,* and that was the contemporaneous appearance of an enormous mass of minute staff-like bodies, precisely similar to those mentioned above as occur-

ring during the germination of *Gymnosporium arundinis.* I did not ascertain as a fact, but I suspect, that these small bodies were produced from the interior of the germinating spores; and if this be so, it is not impossible that they may be possessed of some fecundative power; for although there has lately been, perhaps, too great a tendency to consider every small unaccountable vegetable organism as connected with impregnation, still, with what is now known with regard to the Algæ, and what is suspected in the lichens, it is not unreasonable to suppose that the male sexual organs of fungi, if they exist, will prove to be of a nature somewhat similar to the bodies just mentioned.

Triposporium (sp.?)—In fig. 40, I have drawn the fruit of a Triposporium, which occurred in January, 1855, near Bexley, in Kent, upon a small fallen branch. It differs from *Triposporium elegans* in the colour of the threads and spores, which are olive brown, with a tinge of green, and much darker to the naked eye than those shown in Corda's fig. in the 'Flore Illustrée,' tab. x. The branches of the filaments also do not exhibit the bulbous enlargement at the base which is so peculiar a feature in *Triposporium elegans.* Mr. Berkeley, who, at my request, kindly examined one of my specimens, thought the plant was *Triposporium Ficinusium,* which is figured in Sturm's 'Deutschlands Flora;' but the spores of *T. Ficinusium* are of a somewhat different colour, and are not so much elongated, as will be seen by comparing fig. 40 with the plate in Sturm's work. (See Abt. iii, Heft 30, fig. 8.) I may observe that the tufts of my Triposporium are accompanied by a vast number of the perithecia of some Sphæria, the perithecia being surrounded by and embedded in the threads of the Triposporium. It is probable that the spores of the latter may be only a secondary product of the Mycelium of the Sphæria. Unfortunately, the perithecia are barren, so that I have been unable to ascertain the species of the Sphæria.

Clonostachys araucaria, Corda, 'Flore Illustrée,' tab. xv. p. 31.—I have found this mould in my own neighbourhood and also in Wales, in both instances forming white patches upon the bark of small twigs. It is remarkable for the peculiar arrangement of the spores, which form long dense spikes like ears of corn. It is figured also in Bonorden's 'Handbuch,' pl. vii, fig. 155, under the name of *Stachylidium araucarium.* Corda's specimens appear to have grown upon garden mould, but his description of the habitat is ambiguous.

Zygodesmus fuscus, Corda, 'Einleitung,' pl. B. 8, fig. 1; 'Icones Fungorum,' vol. iv, fig. 81.—I have found this mould near the Hassock's Gate Station, on the Brighton Railway, and

also in the neighbourhood of Tunbridge Wells, upon the bark of fallen branches; it is easily recognised by the reddish-brown colour of the filaments, and by the echinulate spores, but I have found it difficult of observation from the densely tangled mode of growth of the flocci. The structure is not always such as is represented in Corda's figures, where the spores are borne singly upon the tips of short filaments proceeding from the main flocci. I have distinctly seen three sterigmata produced at the apex of a fructifying thread, and the latter was of some length, and slightly swollen at the apex, not a short, stiff, pointed thread as in Corda's figures. Fig. 41 represents a fertile thread, magnified 220 diameters, and by the side of it are shown three spores similarly magnified. The fertile threads sometimes, I think, produce four sterigmata.*

Coryneum Kunzei, Corda, 'Icones Fungorum,' vol. iv, taf. x, fig. 151.—On oak, Shooter's Hill Wood, autumn, 1853. Corda distinguishes this species from all other Corynea by the nature of the epispore, which he states to be *continuous*, whereas, in the other species, he considers the fruit to consist of a number of distinct cells united together. I have, unfortunately, mislaid my specimens, and am unable to test the accuracy of Corda's views of their anatomy, but I suspect there is no real difference in structure between this and the other species. *Coryneum Kunzei* is stated by Corda to be very rare, and I do not know that it has occurred in England except in the above locality.

Trichia cerina, Ditmar.—Peridium ovoid, of a greenish yellow colour; stem elongated, fuliginous; sporidia globose, colour of the sporidia and capillitium the same as that of the peridium. (Ditmar, in Sturm's 'Deutschlands Flora,' t. xxv, p. 51. *Trichia clavata, β. olivascens*, Fries, 'Syst Myc.,' iii, p. 186.) On wood, Sketty, near Swansea, September, 1855.

My specimens accord well with Ditmar's figure and description. Fries considers the plant as only a variety of *Trichia clavata*, but the latter has a yellow shining peridium of a very different appearance. There is also a marked difference in the spiral threads. In *Trichia cerina* the threads are pale coloured, and taper gradually to a very thin point at each extremity; the spiral markings are very delicate, and the threads themselves are simple, detached from one another, and of a definite and moderate length. In *Trichia clavata*, on the other hand, the threads form an extensive complicated

* Mr. Berkeley thinks it possible that the species of Zygodesmus may be conditions of certain Thelephoroid Fungi. See 'Introduction to Cryptogamic Botany,' Bailliere, 1857.

capillitium, in which it is rarely (if ever) possible to trace a single thread from one extremity to the other, and their colour is darker. The markings also are strongly defined, and altogether very different from the very delicate ones of *Trichia cerina.*

Trichia nigripes, Fries, 'Syst. Myc.,' iii, p. 186.—Gregarious, peridia various in form, even, yellowish; stem very short, blackish; capillitium and sporidia of a yellowish ochre. Near Eltham, Kent, and near Weybridge, in Surrey; common.

This species, as Fries has remarked, is closely allied to *Trichia varia*—indeed, the elaters of the two are (generally speaking) not distinguishable. The peridia, however, of *Trichia varia,* are considerably smaller, of a brighter yellow, and frequently assume a reniform shape, which I have never found to be the case with *Trichia nigripes.* The stem of the latter varies much, and is sometimes quite obsolete. In all the specimens which I have found the peridia are uniformly ovoid, and the lower part when empty has the transparent, shining, skinny appearance noticed by Mr. Berkeley in *Tr. clavata.* I have figured the elaters of this species, in a paper on those organs, in the 3d vol. of this journal.

Trichia rubiformis, Pers.—Weybridge, January, 1856.

Some confusion seems to exist between this plant and *Trichia Neesiana.* The two are figured side by side in Corda's 'Icones Fungorum,' vol. i, taf. vi, 288 B, 288 c, and are, at first sight, very different in appearance. The threads of the former are represented as being smooth, and those of the latter as strongly echinulate. The *peridia* in the Weybridge specimens exactly resemble fig. 288 B, but the threads are completely covered with spines. I cannot help thinking that Corda has figured the threads of some other species by mistake, for, in his previous memoir, 'Ueber Spiral-faser-zellen,' he has represented the threads of *T. rubiformis* as spinous. It is true that there are some Trichiæ in which the threads, although usually smooth, exhibit occasionally a few spines, but I have never found the extremes of roughness and smoothness united in one species, as must be the case if Corda's figures be correct. There are specimens marked *Trichia Neesiana* in the Hookerian Herbarium, which, through the kindness of Sir William and Dr. Hooker, I have had an opportunity of examining, and the threads are quite undistinguishable from those of *T. rubiformis.* The peridia in the Kew specimens are, unfortunately, in an imperfect condition, but they appear to have been stemless, like those in Corda's fig. 288 c. It is to be observed that the peridia of *T. rubiformis* do not always grow in a fasciculate manner, and the only difference between detached specimens of *T.*

rubiformis and *T. Neesiana* is the absence of a stem in the latter species, a difference hardly sufficient to justify their separation, when it is considered that the broad expanded form of the base from which the peridium springs is common to both species. It is probably therefore right that the two should be united under one species, as was suggested some time since by Messrs. Berkeley and Broome, in the 'Annals of Natural History.'

Trichia Lorinseriana, Corda, 'Ic. Fung.,' vol. i, p. 23, taf. vi, 288 D.—Subsolitary; stem long, of a dirty brown colour, flexuous and furrowed, the ridges between the furrows being sharp edged; peridium turbinato-ovate, smooth above, bursting irregularly or in an operculate manner; spiral threads short, very pale yellow, with very delicate markings, each extremity of the thread tapering gradually to a very long, thin point, the spiral markings not extending into the narrow extremities of the threads. Weybridge, January, 1856.

The above description differs slightly from that in the 'Icones Fungorum,' but I see no reason to doubt that my specimens belong to the species there described. The spiral threads are simple and detached, very similar to those of *Trichia serotina*, from which they differ only in being considerably longer.

With regard to the spiral threads of the British Trichiæ, generally, I may observe that their form, colour, and microscopic structure afford material assistance in the distinction of species: those of *T. nigripes, pyriformis, chrysosperma, serpula*, and *Neesiana* (or *rubiformis*) are figured in vol. iii. of this Journal, Pl. II. The only other British species which have not been already referred to are *Trichia fallax, varia*, and *Ayresii*. Those of *Trichia varia* are not distinguishable from the same organs in *T. nigripes*, but I have found *T. varia* with echinulate threads; and the same thing occasionally occurs in *T. chrysosperma*. I have had no opportunity of examining *T. Ayresii*, but the threads are described as tawny and strongly echinulate. Specimens of *Trichia fallax* exist in the Hookerian Herbarium, but they have been gathered young, before the formation of the threads, and I have seen no other specimens.

I noticed on a former occasion that in *Trichia pyriformis* the membrane of the threads had the property of unrolling itself in a spiral manner, a peculiarity which is still more manifest in *Trichia clavata* and *T. turbinata*. In some threads of the latter which had been soaked in hydrochloric acid, I found that the tube of the thread had burst in several places by a perfectly smooth spiral fissure, thus converting the tube

for short distances at the points of rupture into a flat band, which was seen to be traversed by five bright narrow lines, running longitudinally in the manner shown roughly in fig. 42. These are the markings which Mr. Henfrey has explained as arising from the deposit of a spiral fibre, but which seemed to me to be caused by a ridge in the membrane. I should certainly mistrust my own opinion when opposed to Mr. Henfrey's; but Mr. Busk, who carefully examined some specimens of the threads, has stated to me his decided opinion against the existence of any fibre. The editors of the 'Micrographic Dictionary' have objected that a ridge round a tube is a structure unknown in the vegetable world, but circular ridges were observed by Mr. Berkeley, some time since, in the capillitium of *Arcyria umbrina*, and longitudinal ridges have been noticed by M. Trecul in the vessels of *Impatiens fulva*. The fact of the ridge taking a *spiral* direction can hardly be of importance, more particularly when it is considered that with reference to the narrow band of membrane, by the twisting of which (in some species at least) the threads are formed, the ridges are, in fact, longitudinal. Pringsheim describes the outer coat of the spores of *Sphæroplea annulina* as covered with ridges running, as it were, in meridian lines from pole to pole of the spores.

Trichia ?—On very rotten fir wood, at Weybridge, Surrey, January, 1856.

This is a plant of which the generic position is somewhat doubtful, but it comes nearer to Trichia than to anything else, and as I have only once found it, it will be better perhaps to place it, provisionally at least, in that genus. It differs from the known species of Trichia in the shape of its peridium (which alone would not be of much importance), and in its capillitium. The peridium is globular, of a dull tawny colour, and supported upon a comparatively long stem; the shape will be seen by a reference to fig. 43, which shows two specimens of the fungus slightly magnified. The spores are yellow and globose, and about half the size of the spores of *Trichia chrysosperma*. The capillitium consists of a mass of reticulated threads, not having the usual spiral markings peculiar to Trichia, but spread out at short intervals into broad membranous expansion, the latter having a chequered appearance, somewhat like that of the scalariform vessels in other plants. I am not certain whether these expansions are formed of a single layer of membrane, or whether they are hollow sacs, but I rather think the latter. Fig. 44 shows a fragment of the capillitium, which bears a slight resemblance to the capillitium of *Lycogala terrestris*,

figured by Corda in his 'Icones Fungorum,' vol. vi, taf. ii, fig. 37; but Corda states that the markings in the Lycogala are caused by wrinkles in the membrane, which is not the case in the present plant. It has occurred to me that this fungus may be a true species of Trichia, in which the development of the capillitium has been arrested. I have not had an opportunity of tracing the growth of the spiral threads of the Trichiæ from the state of mucilage in which the plants originate; but in Didymium, I have observed that the commencement of the formation of the capillitium regularly takes place by the drawing out of the mucilage into threads, which threads at first are always expanded at moderate distances into broad membranous spaces precisely similar in form to those in fig. 44; and if the subsequent growth were stopped at that period, the capillitium in Didymium would exactly resemble in form (although not in colour or marking) that of the above plant.

Trichia ?—Glen Alla, near Lough Swilly, County Donegal, Ireland.

This is another doubtful species, for which, as for many other interesting objects of natural history, I am indebted to Miss Wilcox, of Tenby. The peridia are sessile, crowded, subglobose, and of a dull brownish-yellow colour, looking like very small stunted specimens of *Trichia chrysosperma.* The peculiarity of the plant consists in the total absence of capillitium or elaters. The spores are small and subglobose, forming a dull yellow dust in the interior of the peridia. It might be a question, whether the absence of the internal threads would justify its separation from Trichia. Fries, who treats the elaters as secondary appendages of no importance, would probably say not. At all events no such separation could be made upon the faith of the one small specimen in my possession, in which the growth of the capillitium may from some unknown cause have been suppressed.

Ophiotheca chrysosperma.—Under this name I described a new fungus in vol. ii of this Journal, and stated the points of distinction between it and the genus Arcyria, one of which was the existence of a capillitium consisting of two kinds of threads. Since that paper was published, I have found at Sketty, near Swansea, a very minute Arcyria, not belonging to any of the British species hitherto described, and which exhibits a double capillitium of a precisely similar kind. This reduces the difference between Ophiotheca and Arcyria to the single point of the shape and dehiscence of the peridium, and whether this would be sufficient to keep the genera apart, I must leave for others to determine.

Choiromyces meandriformis, Tul. *Rhizopogon meandriformis*, Corda. *Tuber album*, Sow.—A single specimen of this very rare truffle occurred in my own garden, at Blackheath, in the month of November, 1855. I believe only one other specimen of it has been found in England since Sowerby's time, and that was by Mr. Broome, in Marlborough Forest. Mr. Berkeley tells me he has an authentic specimen of Sowerby's *Tuber album*, and that it is the same plant. My specimen was found near the surface, in a somewhat stiff soil, very near the roots of a walnut tree, and in a spot where but few rays of the sun can ever penetrate, and those only for a very short time in the day. It is possible that other specimens may have been destroyed, as the ground for a considerable space within two feet of the spot had been dug out to a depth of several feet for repairing the foundation of a wall. With the exception of this disturbance the ground had not been moved for years, being in a part of the garden where it was impossible to induce anything to grow. A description of this plant is to be found in Tulasne's 'Fungi hypogæi,' and in the sixth vol. of Corda's 'Icones Fungorum.' The spores are globular and covered with sharp excrescences. Fig. 45 represents an ascus with spores magnified 220 diameters. The ascus figured contained only six spores, but the usual number is eight. The spores are of a pale yellow colour. I made a careful search last autumn (1856), in the hope of finding more specimens, but without success.

Claviceps purpurea, Tul., 'Annales des Sciences naturelles,' ser. 3, vol. xx, p. 45. *Sphæria purpurea*, Fr. S. M., ii, 325, &c.

Claviceps microcephala, Wallr., &c.

These two plants, of which the synonyms are too numerous to mention here, have not hitherto, as far as I am aware, been found in their natural state in this country, although they must be of frequent occurrence. They are the ultimate produce of the ergot of rye and other grasses, and the former (*Claviceps purpurea*) has been grown artificially by Messrs. Berkeley and Broome, by sowing the ergot of rye in common garden mould. I have myself procured the growth of the former (*Claviceps purpurea*) sparingly, and of *Claviceps microcephala* abundantly, by merely keeping the two kinds of ergot in a continually moist atmosphere. The nature of ergot, as is well known, had been for many years a subject of discussion, and the views of botanists with regard to it were apparently tending to the opinion in favour of its being a diseased state of the grain of the grasses in which

it occurs, when the matter was taken up by M. Tulasne, who in 1853 published the result of a vast number of observations, and came to the conclusion that the systematic position of the ergots was amongst the Sclerotia, in which they had been placed by De Candolle. According to Tulasne's views, the ergot, although usually causing abortion in the ovary, is quite unconnected with the fruit of the grass attacked by it, and is in fact only a compact Mycelium (*Mycelium condensatum*), which after lying dormant for some months produces eventually a species of Claviceps. He found the *Claviceps purpurea* produced uniformly by the ergot of rye, and *Claviceps microcephala* by the ergot of *Phragmites communis*. In the 'Botanische Zeitung' for February 2d, 1855, Cesati, in a paper on the Nature of Sclerotium, mentions the occurrence of *Claviceps purpurea* upon the *ergot of Phragmites,* and seems to think that this fact throws considerable doubt upon Tulasne's theory. He says,—"Je prie de vouloir bien remarquer ce fait contradictoire a mon avis primitif sur la signification des Sclerots et qui leur ôte davantage l'importance du rôle assigné par M. Tulasne. La même espèce d'ergot serait la base de deux Claviceps fort differens."

I can myself confirm the occurrence of *Claviceps purpurea* on the ergot of Phragmites, for early in last summer (1856) I found a panicle of the previous year of *Phragmites communis* full of ergot, the ergot itself being covered with specimens of *Claviceps purpurea,* without a single specimen of *Claviceps microcephala*. The question then arises how far this fact is consistent with Tulasne's theory, and I confess there seems to me to be considerable difficulty in reconciling the two; although there is the great weight of Mr. Berkeley's opinion on the other side. Mr. Berkeley, in defending Tulasne's doctrine, says—"It is possible that the sporidia of two species of Cordyceps (Claviceps) may be equally capable of affecting the grain of the same grass, though the ergoted grains arising from the action of the two species may not be distinguishable; and even supposing that at one and the same time the ergot might produce *Claviceps purpurea* and *C. microcephala,* no reason can be adduced why the sporidia of either species should not concur in the production of the ergot." From the mention of *ergoted grains,* it would seem that Mr. Berkeley considers the ergot and the grain as in some way connected in growth, and if this were so no doubt the difficulty would be got over, for the same grain might easily harbour the latent Mycelium of the two species of Claviceps, but the essence of Tulasne's theory is that the

ergot is a body unconnected with the ovules of the grass, taking its rise at the bottom of the cavity of the spermatogonium of the Sphacelia or fungoid growth, which is the first symptom of the disease. The difficulty might be got rid of by supposing the ergot to be a compact mycelium of a compound nature, formed by the sporidia of both species of Claviceps concurrently; but the mode of origin of the ergot in the interior of the spermatogonium renders this supposition impossible, except upon the assumption that the spermatogonium itself is formed by the sporidia of both species, and this can hardly be considered probable. The only explanation consistent with Tulasne's theory seems to me to be, that the ergot of the Phragmites, which produces *Claviceps purpurea,* and the ergot of the same grass which produces *Claviceps microcephala,* are *essentially* although not *perceptibly* distinct; and that the ergot of Phragmites producing *Claviceps purpurea* is identical with the ergot of rye, but modified in size by growing upon Phragmites instead of upon rye. It is obvious that this explanation would fail if the two species of Claviceps should be found upon the same identical specimen of ergot, but I am not aware that this has ever been observed. I do not understand from Cesati's statement that the two species were produced contemporaneously, and such was not the case in the specimens which I found in my own neighbourhood.

BLACKHEATH PARK, S.E.;
February, 1857.

On the presence of SILICA *in the* RUBIACEÆ *and in* ACHILLEA PTARMICA. By ADOLPH LEIPNER, Esq.

(The substance of this paper was read to the Bristol Microscopic Society, January 14th, 1857.)

AMONGST the various inorganic elements which we find present in plants, there is hardly one more interesting than silica, either to the amateur microscopist or to the truly scientific botanist. Some microscopic preparations of siliceous parts, obtained from the Equisetaceæ, Gramineæ, from the *Deutzia scabra,* and some other plants in which it has been discovered, are rarely wanting in the limited collection of the tyro, whom they please,—and never, I may say, in the cabinet of the experienced physiologist, whom they still, to some extent, puzzle.

The simple fact of the presence of silica in these plants has

long been known, its position defined, and its quantity determined. It might at first sight appear unnecessary to lay much stress upon the existence of silica in a new order of plants, when we already have the two orders above named affording such abundant examples of its presence, but there are two points of interest in this manifestation of it.

1st, that as yet, so far as I am aware, the presence of silica has not been noticed in any indigenous exogens, and

2dly (which is of more importance), that the silica exists in such small and varied proportion, as to offer vastly superior opportunities for investigating its mode of deposition.

In the Gramineæ and Equisetaceæ the silica occurs chiefly in the epidermis, where it exists in the form of a siliceous tissue, exhibiting all the details of the epidermis, the outlines and exact form of the epidermic cells and stomata; and enters, moreover, into the composition of all the various structures which are developed from it, such as spines and hairs. After having destroyed all organic matter, either by burning, or, what is still better, by boiling in nitric acid and subsequent charring, we therefore still retain the epidermic structures in the form of what might be called a siliceous cast.

With regard to the Rubiaceæ, I have to make the same remark, viz., that it is chiefly, if not solely, in the epidermis that silica exists. But in order to define its exact position, it will be desirable to recall attention to the structure of the epidermis, and the first formation and after-development of the vegetable cell.

The epidermis consists of two organs, the cuticle and the true epidermis.

The cuticle, which, according to the present opinion of most botanists, is present in all plants, is a thin, colourless, transparent membrane, which overlies the true epidermis, and is in general considered to be a secretion from the outside of the epidermic cells below it. Only the stomata are not covered by this membrane.

Underlying the cuticle is the true epidermis, consisting of one or more layers of flattened and compressed cells. In the order before our notice, the outlines of these cells are all flexuose, the stomata occurring at intervals between them, but only on the under side of the leaves and near the angles of the stem.

It is in the underlying or true epidermis, that the silica occurs not only in the Rubiaceæ, but also in the Gramineæ and Equisetaceæ. But on observing an individual cell, whether epidermic or not, and examining its first formation, its growth and completion, we notice at first a simple vesicle,

formed by a transparent membrane, composed of pure cellulose, an unazotized substance of 2 (C_{12} H_{10} O_{10}) + HO. This membrane is permeable by fluids, not by means of pores, but by the process of endosmose. The interior is occupied with mucilaginous matter, the "protoplasm" of Mohl, which is at first homogeneous, but assumes by degrees a granular appearance, and forms ultimately a layer on the inner surface of the original cell, denominated by Mirbel and others the "primordial or internal utricle." By successive layers on the primordial utricle, the mucilaginous contents of the cells form all the various secondary deposits, which are frequently arranged spirally; but as this process of thickening by deposition advances, the original cell-wall itself becomes finally united with the secondary deposits.

With regard now to the siliceous deposits in cells, it must be remarked, *in limine*, that according to the opinion of all physiologists the original cell-membrane is never composed of anything but pure cellulose; the silica must therefore take, as it were, the place of the secondary cell-membrane and cell-deposits. It is true, that by decarbonizing a siliceous epidermis, either by chemical means or by burning, we obtain a perfect membrane or tissue, in which the cells are all attached to each other; but this does not prove, that the silica entered into the composition of the original cell-membrane; it merely proves that the secondary deposits have, as I before stated, united in their more advanced stage with the primary cell-walls. That this is actually the case, my own observations of the epidermis of canes and straw seem to verify. For by continuing the action of chemical agents, I have observed that the cells separated; from which I have inferred that the cellulose membrane between the individual cells, or in other words the primary cell-wall, had been at length destroyed, which no doubt would have taken place before, had it not been so intimately blended with the secondary siliceous deposits.

So far most physiologists I think pretty well agree; but when we come to inquire further: "What is the relative position of silica and organic matter in the cells? and what is its mode of deposition?" we meet either with very conflicting opinions, or with the most indefinite ideas.

It thus happens, that though I have taken much pains to consult the writings of such eminent botanists and physiologists as Lindley, Henfrey, Balfour, Quekett, and my fellow-countryman Schleiden, with others, I have not been able to meet with even a clearly expressed theory upon this interesting point.

I have already referred to the small and variable quantity of silica present in the Rubiaceæ, and propose to take advantage of this peculiarity in further investigations, by which I hope to arrive at more positive conclusions upon the vexed question of the nature of siliceous deposits; whether they obey the ordinary laws of inorganic bodies, and are simply deposited from the secretions in the manner of *raphides,* as Schleiden appears to think, or whether they are deposited *pari passu* with organic atoms as an integral part of the cell-growth, and in conformity with organic development. In confirmation of the latter supposition, I may here slightly advert to a peculiarity which I have noticed in treating siliceous membranes with nitric acid. If the action is maintained only so long as is required to destroy the adhering organic substances, a siliceous membrane perfectly homogeneous in its structure is presented; but if this membrane be further treated with nitric acid, it loses its homogeneous appearance, and seems to be studded all over with small granules, and the more so the longer it is boiled in the acid. This can be better seen by changing the focus, as some of the granules are more deeply imbedded in the membrane than others.

In concluding this communication I may state that I have found silica in every one of the four genera of which the British Rubiaceæ are composed, viz., *Rubia, Galium, Sherardia,* and *Asperula;* in fact, although I have examined all indigenous plants of this order, with the exception of *Galium pusillum* (L.), *G. erectum* (Huds.), and *G. Vaillantii* (D. C.), I have failed to distinguish the silica-deposit only in *Galium cruciatum* (L.) In all of the others, I have found siliceous epidermic tissue in the stem as well as in the leaves, which depolarizes light if it is present in sufficient thickness; this is especially the case in the prickles, which all these plants have at the margin of the leaves and the angles of the stem. I have also detected it in the cotyledon-leaves of *Galium mollugo* (L.), the only species in which I have examined this organ.

That the Rubiaceæ are not the only exogenous order in which silica is to be sought will appear from the fact, that I have also found it in *Achillea ptarmica* (L.), one of the Compositæ. This plant, which bears the popular name of "sneeze-wort yarrow," possesses a particularly large amount of silica in the prickles forming the sharp double serratures of the leaves, which is doubtless the cause of its errhine properties when powdered and used as snuff.

On the Zoological Position *of* Dysteria.

By P. H. Gosse, F.R.S.

During my stay at Tenby last summer, I had some opportunities of studying the new and singular animal *Dysteria*, the subject of Professor Huxley's excellent memoir in the January number of the 'Quarterly Journal.' While I cannot but admire the skill with which he has worked out the interior structure, some parts of which presented to my own investigations insuperable difficulties; and while, in respect to most of the details which I did succeed in resolving, I agree with him; I had, before his memoir was published, formed a different judgment as to its zoological position.

At first sight I was ready to conclude, with Mr. Huxley, that it was an Infusorium of the family *Euplotidæ;* and, indeed, long before that gentleman's allusion to the *Chlamidodon mnemosyne* of Ehrenberg, I had shrewd suspicions that our Tenby stranger might be no other than that species. The peculiar outline of the lorica, its delicate longitudinal striation, the "large, oval, bright central gland" (contractile space?), the marginal row of cilia, longer in front, playing beneath the overlapping edge of the lorica, the marine habitat, and especially the brilliant rose-coloured vesicles, are all characters (remarkable in their cumulation) which point to such an identification. It is true there are important diversities between *Chlamidodon,* as described and figured, and our *Dysteria;* but those who have been accustomed to examine minutely the figures of the eminent Prussian zoologist, and to compare them with the living animals, will not hastily pronounce their identity impossible.

Presuming *Dysteria* to be an Infusorium, it must be a species *sui generis,* with no close affinity with the *Euplotidæ.* An animal whose soft parts are enclosed between two deeply *compressed* valves, and which crawls by the aid of a hinged shelly foot, is widely different from one greatly *depressed,* covered with a dorsal plate, and whose organs of locomotion are short flexible setæ, scattered over the soft ventral surface.

But I am by no means sure that it should be placed among the Infusoria at all. Mr. Huxley observes that "the absence in an animal which takes solid nutriment, of an alimentary canal with distinct walls, united with the presence of a contractile vesicle, with the power of transverse

fission, and with cilia as locomotive organs, is a combination of characters found only in the Infusoria."*

Now the presence of a contractile vesicle, and of locomotive cilia, are quite as characteristic of the Rotifera as of the Infusoria. The absence of an alimentary canal is, I think, not proved: it seemed to me that the animal possessed a defined digestive cavity, though very ample. In *Sacculus*, —an indubitable Rotiferon, which carries its large eggs in the manner of a *Brachionus*,—the alimentary canal, without apparent distinction of stomach and intestine, is so large that it occupies fully five sixths of the whole volume of the lorica; and though it is invariably found filled with a green alga, on which the animal feeds, the walls of the digestive cavity are not better defined than in *Dysteria*. There remains then only the fact of increase by transverse fission. This, I confess, is a strong point, if well established. But it does not seem certain, from Mr. Huxley's words, whether he witnessed the progress of constriction, from an early stage, until two perfect animals were formed out of one, or only saw an individual so strongly constricted that the result seemed legitimately inferible. If the latter was the case, is it not just possible that it was an example, not of spontaneous fission, but of malformation, instances of which are frequent among the highest animals? It is highly worthy of note that the *nucleus*, so characteristic of the Infusoria, *was not found, even under careful search with acetic acid.*

The presence, position, and movements of the foot, hinged, as it is, upon a tubercle, and the form of the principal organs of manducation, seem to me to determine the place of *Dysteria* within the class Rotifera; while, at the same time, the lack of internal motion, the apparent want of distinct muscle-bands, the great extent of the vibratory cilia, and the absence of a rotatory arrangement, show that it occupies one of the vanishing points of the class.

If this allocation be admissible, it is interesting to inquire, what are the recognised forms among the Rotifera to which this animal makes the most obvious approaches. The following points of relationship occur to me:

1. The oval form and bivalve character of the lorica suggest the *Coluridæ*, with which the creature associates; but *they* have the valves separate only on the ventral edge.

2. The *Salpinadæ*, on the other hand, have the lorical plates separate down the dorsal edge, but soldered together ventrally, the foot playing in a fissure.

* Loc. cit., p. 82.

3. The excavation in the interior part of the head causes the part above it to assume the form of a hook, the point of which is downwards and forwards.

Now in the *Coluridæ,* as well as in some other allied genera, a broad frontal hook is very characteristic. It is true, that in these it is apparently articulated to the lorica, of which it forms a firm appendage, and is endowed with separate motion. In *Stephanops,* however, it is fixed and immoveable.

From these slight analogies we may perhaps link the form with *Colurus* and its allies.

But the predominance of resemblances is with another group,—that which includes *Monocerca* and *Mastigocerca;* and some of these points of similarity are the more interesting, because they are such as already isolate (though in a much less conspicuous manner) these genera from the more normal Rotifera.

1. They are single-toed; whereas the majority of footed Rotifera are two-toed.

2. Some of them are unsymmetrical; as *Mastigocerca,* in which the dorsal carina leans over to the right side, and the left series of manducatory organs is more developed than the right; and *Monocerca,* in which the right malleus is wanting, and (in some species) the antennal processes and the frontal spines are unequally developed.

3. The manducatory apparatus is of far greater comparative length in these genera than in any other known Rotifera; in *Monocerca porcellus* and *M. stylata* approaching, and in *Mastigocerca carinata,* equalling, half the length of the lorica.

4. These genera, when crawling on a smooth surface (as a plate of glass), are able to render themselves stationary, and acquire a *point d'appui* for their progression, by the curious provision of a thick glutinous fluid. This is secreted in the hinder region of the body, and thrown out in a copious stream, which may be often seen passing down the long foot like a thick entwining cord, and then left trailing behind, as the animal moves forward. Now this interesting contrivance is paralleled in the new form we are considering; for Mr. Dyster tells me that the point of the foot remains glued to the glass after death, "probably from some exudation."

From these analogies, I incline to give to this animal a place in the family *Monocercadæ,* as a very aberrant genus. I consider that it has remote relations also with the *Salpinadæ,* and especially with the *Coluridæ* (through *Monura*); and that it *is* an annectant form between the Rotifera and the

Infusoria, with a preponderance of the characters of the former class.

I propose the following generic characters for the animal:

CLASSIS ROTIFERA.

FAMILIA MONOCERCADÆ.

Genus *Dysteria* (Huxley).

Lorica bivalvis, inæquivalvis, ferè totâ margine hiante. Corporis facies capitales et ventrales ciliatæ. Apparatus manducatorius valdè elongatus, in mastace dignoscenda non inclusus. Cavitas digestiva amplissima, simplex. Pes inarticulatus, indivisus, spathulatus, compressus.

Sp. *D. armata* (Huxley). Species unica.

On COMPOUND NUCLEATED CELLS. By J. HEPWORTH, Esq.

ALTHOUGH many writers speak very positively as to the compound nucleated cell being invariably a characteristic sign of cancer, my observations for some years past have led me to doubt the truth of this. I believe it is more frequently found than otherwise; but not always.

H. J., a female, aged fifty-five years, applied to me, having an ulcer on the upper lip, which had all the characteristic signs of cancer, *except the nucleated cell*. I removed a V-shaped portion of the lip, including the disease; the parts healed, and I heard nothing more of the case until after a lapse of two years, when the woman presented herself again, with a similar ulcer on the nose; so situated, that the knife could not be used with advantage. It resisted every remedy, and gradually went on, though slowly, to a fatal termination; after destroying the nose, and dipping into the orbit.

I frequently examined very carefully the secretions from the surface, and from time to time snipped small portions from the parts; but never detected a nucleated cell; I only found pus-globules, altered blood-discs, and exudation-corpuscles.

L. T., a man, aged forty-five, died of cancer of the stomach; on examination, the greater and lesser omenta colon, and stomach were all shrivelled up into a hard scirrhous mass, the coats of the stomach were three quarters of an inch thick, the pylorus was ulcerated; although I had no doubt as to the nature of the case, I detected no nucleated cells.

There are some objects that we occasionally meet with which have some resemblance to nucleated (cancer) cells, at first sight, but on closer examination they are found otherwise; for instance, in the deposits after desquamatory inflammation of the tubuli uriniferi, the epithelial scales, when clustered together, and heaped one upon another, have somewhat that appearance (fig. 1, Pl. IX). There are other compound cells, which have not the least resemblance to the so-called cancer-cell, as fig. 2, which represents cells found in the fluid drawn from a sac in ovarian dropsy, in which there were abundance of pus globules; indeed these appear to have formed the nuclei of the compound cells. The other drawings represent *cancer-cells*, from different sources. (Fig. 3.) Cells from a cancroid tumour of the brain. (Fig. 4.) Cells from epithelial cancer of the fore-arm, of a fine old woman of eighty-three years of age; now under treatment; the axillary glands have become affected with the disease, which is progressing rapidly. (Fig. 5.) Cells from the mamma. (Fig. 6.) Cells from the uterus.

Dr. Inman's case, of Liverpool, is an excellent illustration of the "Practical use of the Microscope." If other gentlemen would publish the results of similar observations, it would lead to useful investigations by many.*

* 'Quart. Journ. Micr. Science,' vol. v, p. 20.

TRANSLATIONS.

Algarum Unicellularium Genera *nova et minus cognita, præmissis* Observationibus *de* Algis Unicellularibus *in genere.*

New and less known Genera of Unicellular Algæ, *preceded by* Observations *respecting* Unicellular Algæ *in general.* By Alex. Braun. (Lipsiæ, 1855; with six Plates.)

Continued from No. XVIII, p. 96.

The organs of fructification, and in particular the cells, by which the *Algæ* and cryptogamous plants in general are propagated, have received the most various names, for the most part insufficiently defined and applied in different senses.* Propagative cells undoubtedly occur widely differing among themselves, and frequently differing, and this is a point of the greatest importance, in the same plant.† For some differ but little, others as widely as possible from the vegetative cells; some are endogenous in their origin (in a simple parent-cell, or in two conjugated cells), some acrogenous;‡ they may be enclosed in a membrane either soft or rigid, simple or multiple; they may be inert or active (furnished with motile cilia); some are subservient to fecundation either in a direct § or indirect || manner, some to germination, others altogether sterile.¶ Among those which

* The following terms have chiefly been employed: *spora, sporidium, sporidiolum, spermatium, speirema, sphærospora, zoospora, gonidium, gemmidium, conidium, gongylus, spermatozoidium, antherozoidium,* &c.

† Fructification of the double kind is extremely common; of the triple kind instances are afforded amongst the *Algæ*, in most of the *Florideæ*, in *Œdogonium, Vaucheria, Saprolegnia,* and *Chlamidococcus;* among the Lichens, in *Scutula* (Tulasne, 'Ann. d. Sc. Nat.,' 17, p. 118, t. 14); among the Fungi, in *Cenangium Frangulæ* (Tulasne, l. c., 20, p. 136, t. 16), *Bulgaria* (ib., p. 129, t. 15), *Dacrymyces* (ib., 19, p. 211, t. 13), *Erysiphe, Stemphylium* (De Bary, 'Verh. des pr. Gartenbauer,' 1853, p. 178, t. 2), *Peronostoma* (from the very recent observations of Caspery), &c.

‡ *Conidia*, stylospores, basidiospores, and *spermatia* of the Fungi and Lichens.

§ *Spermatozoidia* of the *Filicoideæ, Muscoideæ, Fucoideæ, Florideæ; spermatia* of Lichens and Fungi.

|| Microspores of the *Lycopodiaceæ* and *Rhizocarpeæ.*

¶ Most *microgonidia* (*Chlamidococcus, Pediastrum, Stephanosphæra, Hydrodictyon, Cutleria*), the *pseudo-gonidia* (*spermatosphæria,* Itzigs.) of *Spirogyra,* &c.

germinate, some require fecundation, others germinate spontaneously, some at once, others after a long or shorter term of rest, some in totality, others after throwing off the perispore; most producing only a single individual, whilst some (under a divided germination) give rise to several individuals.* Propagative corpuscles (spores), moreover, also occur, either bicellular or multicellular. This being the case, a diversity of terms also becomes requisite, but what these should be, and upon what principle they should be framed, is at present not easy to determine, seeing that numerous considerations relative both to the origin and to the structure of the propagative cells, but more especially concerning their physiological import, fecundation, and germination, have not as yet been sufficiently inquired into. The terms, therefore, here set forth are proposed more for the temporary purpose of their being considered and judged of, than for use.

The author, in his work on 'Rejuvenescence in Plants,' p. 143, has endeavoured accurately to determine the difference between *spores* and *gonidia*, a difference which, at the present day, though difficult to sustain, it is neither incongruous nor useless to discuss. *Gonidia* are formed either in the vegetative cells themselves, or in cells only slightly differing from the vegetative character, filled with the same material, and for the most part resembling the vegetative cells in nature and colour; so that they represent, as it were, a cytoplasma liberated from the envelopes. Covered with a special delicate and soft integument, they proceed to germinate at once and in totality. From *gonidia*, which move by means of vibratile cilia, a transition to ciliated spermatozoids is afforded through the sterile microgonidia.† *Spores*, on the other hand, originate within cells more widely differing from the common vegetative cell, and are themselves distinguished by the altered nature of the contents and their peculiar colour. Furnished with special coats, double or multiple,

* The multicellular spores of most Lichens and Ascomycetes, many Gymnomycetes, and also of some Hymenomycetes (Tulasne, 'Ann. d. Sc. Nat.,' III, 9, p. 215, t. 13, *Dacrymyces*), represent in all respects compound spores, protruding in like manner from every cell, germinal filaments. The multicellular spores of *Pellia* ('Hofmeister vergl. Unters.,' p. 10, t. 4; Gröaland, in 'Ann. des Sc. Nat.,' IV, p. 13, t. 2), are of a different nature, representing a single germinal plantule, formed by a premature division of the primordial cell.

† Whether the gonidia of Lichens are altogether analogous with those of *Algæ* is not quite clear. Endogenous, as it would seem, in their origin, they agree with the gonidia of *Algæ*, but remaining within the texture of the *thallus* they are changed into free vegetative cells, which produce new and repeated series of *gonidia*.

they constitute, as it were, tunicated *gonidia;* in their germination, rupturing and throwing off the envelope (exosporium). Quite inert and dormant, as it were, they retain their vitality until the proper period for their germination arrives. But that the male function is also not incongruous with the form of a spore is shown in the pollen of phanerogamous plants, which is directly subservient to fecundation; and in the microspores of the Lycopodiaceæ and Rhizocarpeæ, from which fecundating spermatozoidia are produced.

Spores and *gonidia,* thus defined, agree in this, that they arise from an endogenous and a free formation of cells.* The acrogenous propagative cells constitute a series differing from both, which, formed at the summit of the supporting cell,† and at length proceeding to form an articulated series of cells, might be generally termed *conidia.* These occur very rarely in the class of Algæ,‡ but are extremely common and of varied construction in the Lichens and Fungi; some being very closely allied to vegetative cells (*conidia,* from the *mycelium* of Fungi), some assuming the nature of spores, whilst others, again, are analogous, in a certain sense, to spermatozoids; that is, they do not germinate, and the author is not aware that they are subservient to fecundation (*spermatia*) of Lichens and Fungi.

The author proposes the following conspectus of these organs, based upon the foregoing considerations:

A. A series of GONIDIA (*macrogonidia* and *microgonidia,* according to their size in the same species); *protogonidia, deuterogonidia, telogonidia,* if transitional generations of gonidia exist:

a. Gonidia immotile, in their nature very closely approximating vegetative cells (all germinating without fecundation): PHYTOGONIDIA:

* In the ultimate generation of cells, naked: *Glæocapsa, Oscillaria, Scytonema, Mastichonema, Zooglœa* (the gonidia of *Zooglœa,* though tremulous, have no vibratile cilia);

** Formed by the division of the contents of a single cell: *Scenedesmus, Cœlastrum;*

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* By a free cytogenesis, though in the widest sense of the term, the sense in which it is very recently defined by Pringsheim in his observations on the structure and origin of the plant-cell, who comprehends under the term "free cytogenesis," every formation of cells arising without inflexion of the cytoderm and from the contents alone. (Pringsh., 'Unters. üb. d. Bau u. die Bildung der Pflanzenzelle,' 1854, p. 62.)

† In what way these are formed, whether by a process of division, or by the coalescing of a free cell with the parent utricle, demands further inquiry.

‡ In *Batrachospermum* and *Lemanea.*

*** Formed by the union of the contents of two conjugated cells: *Diatomaceæ;*

**** Produced within special organs: "gemmidia" in "cystocarps," as in the *Floridiæ* (?).

b. Gonidia motile by means of vibratile cilia, otherwise differing but little from the common shape of cells (oblong and rounded), ZOOGONIDIA (vulgo "zoospores"):

α. Germinating (without fecundation), producing normal individuals:

* Solitary: *macrogonidia* of *Vaucheria, Œdogonium, Bulbochætes, Cutleria; gonidia* of *Coleochætes, Chætophora,* &c.;

** Numerous, arising from successive generations in the same cell (telogonidia): *Characium, Ulothrix;* macrogonidia and (?) microgonidia of *Ulva;*

*** Arising in the same cell, in a group by the simultaneous division of the cytoplasm (protoplasm): *Codium, Codiolum, Bryopsis, Hydrocytium, Chætomorpha, Cladophora, Laminaria; macrogonidia* of *Hydrodictyon.*

β. Germinating, but producing only depauperate individuals, which soon perish (pauperculæ): microgonidia of *Œdogonium, Bulbochætes;*

γ. Sterile, neither germinating nor fecundating: microgonidia of *Hydrodictyon, Pediastrum, Stephanosphæra, Chlamidococcus, Cutleria;*

δ. Fecundating (*spermatogonidia*):*

* Produced in numbers in the same cell: *Fucoideæ;*

** One in each cell: *Florideæ.*†

c. Gonidia motile by means of cilia, further removed from the nature of cells, filiform and twisted in spiral forms (*spermatozoidia*):

One formed in each cell: *Characeæ, Muscoideæ, Filices, Equisetaceæ, Lycopodiaceæ, Rhizocarpeæ.*

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* The spermatozoids, as they are termed, of the *Fucoideæ,* although, since the experiments of Thuret and Pringsheim, no doubt can be entertained as to their function, are widely different, with respect to their form, from the spermatozoids of the higher Cryptogams, and agree in all points with the germinating gonidia of the *Ectocarpeæ, Myrionemeæ, Laminarieæ,* &c. Agardh (Spec. gen. et ord. Alg. I, p. 9) terms the Zoogonidia in general and the spermatogonidia of the *Fucoideæ* in particular "Sporidia," speaking of them in the following words: "The sporidia of the *Fucoideæ* are without doubt analogous, on the one hand, with the sporidia of the *Zoospermeæ,* and on the other with the spermatozoa of the *Musci, Hepaticæ,* and *Characeæ.* It is of little moment whether their functions be the same or different. That the most various functions may be assigned to analogous organs is shown by very numerous examples. The pollen and spores are the same organs, but differing in function."

† That the spermatogonidia of the *Florideæ* move by means of cilia, has been noticed in several genera by Derbés and Solier ('Mém. sur la Physiologie des Algaes').

B. A series of SPORES (macrospores and microspores, if differing in size in the same species; hypnospores, if dormant for a long time):

a. True *germinating* spores (some without fecundation):

α. Simple, developed into a single germinal plantlet:

* Produced singly in each naked cell: *Œdogonium*, *Bulbochæte*, *Ulothrix* (*Hormotrichum*), *Vaucheria;*

** Gregarious in each naked cell: *Saprolegnia*, *Sphæroplea;*

*** Solitary in a pair of conjugated cells: *Desmidiaceæ*, *Zygnemaceæ;*

**** Serial, in cells (*asci*) of a compound organ (*apothecium*, *perithecium;* the simple spores of some *Lichens* and *Ascomycetes*);

***** Quaternary in the primary maternal cells (singly in the secondary) within compound organs: *Florideæ* ("sphærospores" without fecundation?), *Musci*, *Hepaticæ*, *Filices*, *Equisetum*, &c. (fecundation 0).

β. Compound (multicellular),* throwing out several germs,—PHRAGMATOSPORES, POLYPLASTIC SPORES:

Serial in the cells (*asci*) of a compound organ (*apothecium*, *perithecium;* most *Lichens* and *Ascomycetes*).

γ. Sectile, breaking up within the perispore into several gonidia, each of which germinates:

* Undergoing fecundation: *Fucoideæ;*

** Without fecundation: *Closterium* (?), *Euastrum* (?), *Rivularia* (?).

b. Subservient to fecundation—ANDROSPORES:

α. Directly fecundating:

Pollen of phanerogamous plants.

γ. Indirectly fecundating, producing spermatozoidia in their interior: microspores of *Selaginella*, *Isoëtes*, and the *Rhizocarpeæ*.

C. A series of CONIDIA:

a. *Conidia* in the more restricted sense of the term, arising from a *thallus* (*mycelium*) differing very little from vegetative cells, for the most part smooth-skinned (leptodermatous), germinating at once and in totality:

To this category appear to belong the spores of *Batrachospermum* and *Lemania;*† and obviously those of the Hyphomycetes, as well as of the Pyrenomycetes (*Erysiphe*) and Hymenomycetes (*Dacrymyce*).

b. ACROSPORES of authors (*sporoconidia*), produced in special organs more distinct from the thallus; widely different from vegetative cells, for

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* The individual cells of compound spores have by some been termed "sporidia," terms analogous to "folium" and "foliolum;" Fries employs the term "sporidia" to designate the naked spores of the Hymenomycetes.

† The spores of *Lemania* arising from the separated joints of the internal filaments germinate together with the perispore itself. (*Vid.* Wartmann, Anat. und Entwickelungsgeschichte der Algengattung "*Lemania*" (1854), p. 12, t. 3, f. 5.

the most part pachydermatous, and germinating through pores or a rupture of the exospore:

The naked and acrogenous spores of most of the Coniomycetes and Hyphomycetes (often compound or multicellular); the basidiospores of the Gasteromycetes and Hymenomycetes (for the most part simple); the stylospores of the Ascomycetes (*Bulgaria*, *Cenangium*, *Dermatia*, &c.) and of the Lichens (*Scutula*).

c. Spermatia (*spermatoconidia*, *androconidia*), very slender, minute cells, often exhibiting a tremulous motion, sterile or fecundating:*

In the Lichens and Ascomycetes, and also in the Hyphomycetes, *e. g.*, in *Trichothecium;* and the Hymenomycetes, *e. g.*, in *Tremella* and *Dacrymyce.*

With respect to the parts, lastly, by which the propagative cells are produced, it is well known that, in the different orders of Cryptograms, parts widely differing in value are designated under the same name, or that parts essentially identical have received different appellations, so that a more accurate terminology is much required. Thus it is, in the first place, desirable to distinguish in the organs of fructification those which are directly such, and simple, *i. e.*, parent-cells, within which propagative cells are generated, and those which more remotely perform the function and are compound, —those within which parent-cells are formed and contained. The former the author would term—1, *sporocytia*,† when they contain spores; 2, *goniocytia*, if containing *gonidia;* 3, *spermatocytia*,‡ if containing spermatogonidia or spermatozoidia; and the latter, for the same reason—1, *sporangia* (*sporocarpia*, Schleiden), to which belong the sporangia of Ferns and Equisetaceæ, analogous to which are the loculaments, or *thecæ*, of the anthers in phanerogamous plants, and also the *sporangia* of two kinds of the Lycopodiaceæ ("antheridia" and "oophoridia," Spring), those of the *Musci* and *Hepaticæ*, and lastly the *apothecia*, or *cymatia*, and *perithecia* of the Lichens and Pyrenomycetes, as well as their *pycnides* (Tulasne), containing stylospores, and the *peridia* of the

* Tulasne has noticed the germination of the spermatia of *Claviceps purpurea* (*Sphacelia segetum*), of *Sphæria typhina*, and *S. Laburni;* and Hoffmann ('Bot. Zeit.,' 1854, p. 268) the incomplete germination of the spermatia in *Hagenia ciliaris*, *tubercularia*, and *Trichothecium roseum;* the boundary, therefore, between the spermatia and other kinds of conidia would seem to be but ill defined.

† Schleiden terms these organs "Sporangia," a term elsewhere frequently used to express compound sporiferous organs; in the *Algæ* they are called sometimes "sporocysts," sometimes "perispores" (as in the *Fucaceæ*); the sporocytia of Lichens, Pyrenomycetes and Discomycetes are known under the names of "asci" and "thecæ."

‡ "Antheridia" of the *Fucaceæ*.

Gasteromycetes; 2, *goniangia*, to which would appear to belong the cystocarps of the Florideæ and the conceptacles of the *propagula* (*Scyphi*) of the *Hepaticæ* (*Marchantia, Blasia*); and 3, *spermatangia*, including the spermogonia (Talasne) of the Lichens and Fungi, and the antheridia of Ferns, Equisetaceæ, Mosses, Hepaticæ, and Characeæ. The term *sporocorpium*, lastly, should be reserved for organs distinct from the vegetative parts in which the sporangia themselves are inclosed, and which occur in the family of the Rhizocarpeæ. These organs are commonly termed "receptacles," or "conceptacles," under which term, indeed, widely different sporangiophorous organs are included, *e. g.*, the peculiar leaves bearing sporangia externally in *Equisetum* (*sporophylla*, Schleiden, *sporidochia*, Link, *carpophora*, Bisch), to which may be added the fertile fronds of the Ophioglosseæ and of some Ferns; and besides these, the peltate inflorescence (to use such a term) of the *Marchantiæ*, as well as the altered parts of the *thallus*, containing associated sporangia, in the Fucaceæ (*carpomata*, Kütz), to which the *stromata* of the Pyrenomycetes are in some respects analogous.

These introductory observations are succeeded by the description of several new or less known genera, viz., *Codiolum, Hydrocytium, Characium, Sciadium, Ophiocytium, Hydrodictyon*, and *Pediastrum* (subdivided into four sub-genera), illustrated with numerous figures.

Cohn *on* Volvox globator.

In a paper recently read before the Academy of Sciences in Paris, Professor Cohn states that his own observations on the Volvocineæ have convinced him that the members of that family must be regarded as belonging to the vegetable kingdom, and that the *Volvox globator*, in particular, is properly placed among the Algæ. In this singular plant, as well as in *Eudorina, Gonium, Stephanosphæra*, and other Volvocineæ, each spherule is, properly speaking, not so much an individual as an association or family of individuals,—a sort of vegetable polypary. The globe of *Volvox* is formed at its periphery of an infinitude of very minute hexagonal cells, attached to each other in the same way as are the elements of an epidermic tissue. Each of the cells is furnished with

two motile cilia, and may be compared with a *Chlamydococcus*. The green endochrome is suspended, as it were, in the cavity, being connected with the wall only by means of filiform processes.

Like all the Algæ, the *Volvocineæ* present two distinct modes of reproduction; but up to the present time naturalists have been acquainted with only one of these, consisting in the repeated segmentation of the constituent cells, and resembling the fissiparity of *Chlamydococcus* and *Gonium*, or that of most of the Palmellaceæ.

The second mode of reproduction of *Volvox* requires a sexual conjunction, and is not observed indifferently in all individuals. The spherules, endowed with the sexual function, are distinguished by their volume and the more considerable number of their component utricles; they are generally monæcious, that is to say, they enclose at the same time male and female cells, although the majority of their contents are neuter. The female cells soon exceed their neighbours in size, assume a deeper green colour, and become elongated like a matrass towards the centre of the *Volvox*. The endochrome of these cells does not undergo fission. In other cells, on the contrary, which acquire the size and form of the female cells, the green plasma may be seen to divide symmetrically into an infinity of very minute particles, or linear corpuscles associated into discoid bundles. These are furnished with vibratile cilia, and oscillate, at first slowly, in their prism, but the movement soon becomes more active, and the bundles speedily break up into their constituent elements. The free corpuscles are very agile, and it is impossible to regard them as anything but true spermatozoids; they are linear and thickened at the posterior extremity; two long cilia are placed behind their middle, and the rostrum, which is curved like the neck of a swan, possesses sufficient contractility to execute the most varied movements. These spermatozoids, so soon as they are able to disperse themselves in the cavity of the *Volvox*, quickly crowd around the female cells, into which they eventually penetrate; arrived there, they attach themselves by the beak to the plastic globule, destined in each cell to form a *spore*, and with which they are gradually incorporated. Fecundation having been thus effected, the reproductive globule becomes enveloped successively by an integument exhibiting conical pointed eminences, and by an interior smooth membrane; the chlorophyll which it contained is now replaced by starch grains, and a red or orange-coloured oil. This is the condition of the spore at maturity, and occasionally forty of these bodies may be counted in a

single globe of *Volvox*. The germination of these reproductive bodies has not yet been observed, so that their history cannot be regarded as complete; but from analogy it may, in the meanwhile, be assumed that they germinate in the same way as do the spores of *Ædogonium, Sphæroplea,* and other Algæ belonging to the same order. It may be maintained, moreover, as certain that the *Sphærosira volvox,* Ehr., is nothing else than a monæcious *Volvox globator;* that his *Volvox stellatus* is also *V. globator*, observed at the time when it is filled with stellate spores; and, lastly, that the *V. aureus* of the same author differs from the other forms of the same species, simply in the smooth [and coloured] condition of the spores.

[*Note.*—With respect to the relations of *Volvox aureus* and *V. stellatus* to each other and to *V. globator*, observations precisely in accordance with those of Professor Cohn are contained in a paper by Mr. Busk, in the first volume of this Journal; and the description there given of the formation of the hypnospore, in the variety termed *V. aureus,* corresponds, in all respects, excepting the introduction of spermatozoids, with that above afforded. In the same place it is also hinted that this orange-coloured spore of *V. aureus* represents the "still-" or hypno-spore of other Algæ. It is also suggested, in the same paper, that *Sphærosira volvox,* Ehr., "may eventually be found to represent a peculiar mode of development of the same species." It is also noticed that the ultimate result of the segmentation of the zoospores in *Sphærosira* consists in the formation of numerous minute ciliated cells or corpuscles, forming by their aggregation a discoid body, in which the separate fusiform cells are connected together at one end. The important discovery (if confirmed by future observation) by Cohn that these fusiform bodies represent the spermatozoids of other Algæ, constitutes the important point in the paper of which the above abstract is given.—Eds.]

On a Peculiar Structure *in the* Columnar Epithelial Cells *of the* Intestines, *in connection with the* Absorption *of* Fatty Matters. By A. Kölliker.

(From the 'Verhandl. d. phys. med. Gesellschaft,' vol. vi, 1855.)

1. The epithelial cells of the small intestine in mammals, birds, and amphibia have on the side turned towards the cavity of the intestine a thickened wall, in which, under favorable circumstances, and with a good microscope, a manifest delicate striation may be perceived; which also, though with far more difficulty, and with certainty almost exclusively in the rabbit, when viewed from above, appears as a fine punctation.

2. This thickened, striated cell-wall, which may be readily perceived even in isolated cells, swells up in water and dilute solutions to more than double its primitive thickness, becomes very manifestly striated, even breaking up, as it were, into separate fibrillæ, so that the cells assume the aspect of ciliated cells. Ultimately water destroys the entire border from without to within, the innermost portion offering the longest resistance. Besides this, water induces two especial changes in the intestinal cells. In the first place, it forces mucous drops out of the uninjured cells, which have been erroneously explained as being swollen cells; and secondly, also, it frequently raises off the thickened membrane *in toto;* both of which circumstances are generally very readily distinguishable from each other.

3. In herbivorous mammals, the thickened and striated membranes are absent in the large intestine, as well as in the amphibia and birds; whilst in the carnivora and in man a faint indication of its presence may be discerned in this portion of the intestinal canal as well; in the stomach the membranes of the columnar cells do not present this characteristic.

4. In the mammalia, the fat before its absorption is transformed into immeasurably minute molecules, in which form it also enters the epithelial cells. The larger oil-drops, which, under certain conditions, are seen within perfectly recent cells, do not necessarily show that the fatty matter had entered in that form.

5. Among the common epithelial cells, there are found in all animals, and in every part of the intestine, other granular cells, of a more clavate form, mostly without distinct nucleus,

and which must be regarded as cells in a state of regeneration, ruptured at the upper end.

To these facts Kölliker subjoins the following *possibilities* and *suppositions,* which he recommends as subjects for further research:

1. The striæ in the thickened cell-membrane are pore-canals.*

2. Should this supposition prove correct, it would seem, in the first place, proper to place these canaliculi in direct relation to the absorption of fat; though, at the same time, it is also conceivable that they possess a more general significance, and that they stand in a general relation to the reception and secretion of material through cells. The former view is supported by the circumstance—

1. That in many animals (herbivorous mammals, amphibia, birds, &c.) the striated, thickened cell-membranes exist only on the surface of the small intestine, whilst they are wanting in its glands, as well as in the large intestine and stomach.

2. The columnar and ciliated epithelium of other localities presents no indication of the existence of a structure resembling pore-canals.

3. That the fatty matters are absorbed in the form of molecules, so minute, as, at any rate, to be capable of penetrating through the canals in question.

* In a note, Kölliker remarks that his supposed pore-canals have nothing in common with the imaginary pores stated by Keber to exist, not only in epithelial cells, but in all other bodies. (*Vide* 'Quart. Journ. Micros. Soc.,' vol. iii, p. 152.)

REVIEWS.

EMPUSA MUSCÆ, *and the disease of the Common House-fly. A contribution towards the knowledge of Epidemics characterised by the presence of parasitic Fungi.* By Dr. F. COHN. Breslau, 1855 (pp. 59, with three plates).

THE subject of this paper is the well-known, curious disease which prevails among common house-flies, at the period when the departing warmth of autumn induces them to seek shelter within doors.

At this time innumerable dead bodies of flies may be seen adhering to the windows, walls, shutters, &c., in all parts of the room. The dead insect, though dry and so friable as to crumble into dust upon the slightest touch, retains so far the attitude of life that it is difficult, without touching, to believe that it is not a living fly on the point of taking flight. Insects in dying usually draw up the legs and cross them beneath the body, but in the case of the disease now under consideration the dead body is supported upon the outstretched legs, whose feet retain their adhesive property, and by the protruded proboscis, with which the fly would seem to be sucking, and by which, even when the feet may happen to be detached, the body is still retained *in situ*. The dead flies in this condition are always surrounded with a halo, about an inch in diameter, composed of a whitish dust, which, upon examination, is found to consist of the spores of a *fungus*. The abdomen is much distended, and the rings composing it are separated from each other, the intervals being occupied by white prominent zones, constituted of a fungoid growth proceeding from the interior of the body. Further examination will show that the whole of the contents of the body of the fly have been consumed by the parasitic growth, and that nothing remains but an empty shell lined with a thin, felt-like layer, composed of the interlaced mycelia of the innumerable fungi.

This disease appears to have been long noticed, though, of course, in the absence of sufficient microscopic assistance, its true nature was not at first known.

First noticed, as it would seem, by De Geer in 1782, it did not escape the acute eye of the illustrious Goethe, who gives an accurate description of the phenomena attending it, and especially of the appearance of the white dust between the rings of the body, and its dispersion in a wide area around the dead insect. Accurate microscopic observations upon it

were made by Nees v. Esenbeck in 1827, though he did not arrive at any very definite conclusion as to the nature of what he observed. But, in 1835, M. Duméril declared the fine white dust to be a *true mould*, which had probably caused the death of the animal, in the same way that plants are killed by different species of *Exysiphe.* He compares it to the "muscardine" of the silk-worm.

In 1841, Mr. Berkeley determined the mould observed by Duméril to be the *Sporendonema muscæ*, Fries., with the following characters: "S. floccis simplicibus in cæspitulos sublobatos albos conglutinatis" ('Systema mycologicum,' 1829, iii, p. 434); the fertile filaments (flocci) are said to be filled internally with serially disposed, spherical sporidia.

Cohn, though admitting that the last-mentioned circumstance may be explained by the action of water upon the contents of the filament, thinks it necessary, in giving a new diagnosis, also to dignify the fungus with a new name, and to erect it into a new genus under that of *Empusa*, with the following characters: "*Empusa*, entophyta, e tribus constans cellulis, quarrum infima in insecti cujusdam alvo evoluta, mycelii instar tortuosa et ramificata superne prolongatur in mediam, extrorsum tandem erumpentem, stipitis vel basidii instar spora simplici, elastice demum protrusa coronatum."

Em. muscæ, n. sp.: Cellula myceliiformi $\frac{1}{200}'''$ lata, sursum in claviformem $\frac{1}{100}'''$ latam excurrente, spora campanuliformi = $\frac{1}{100}'''$.

The author gives a long, interesting, and very particular account of his observations upon this parasitic growth, and finally sums up his conclusions in the following propositions, which include all the main points in the paper.

In a postscript noticing M. Tulasne's observations on the development of the Uredineæ,* he himself, however, admits that they are calculated to throw very strong suspicions upon the correctness of one of the main propositions which it seems to have been the object of this memoir to establish, viz., "that in the fluid which fills the abdominal cavity of the diseased fly numerous cells arise by free cell-formation, which cells, by gradual development, are formed into the tricellular *Empusa*." A sort of equivocal generation, the establishment of which in any case will indeed require very much stronger evidence than has yet been afforded, and especially in the instance of growths like the present, of whose modes of development much still remains to be made out.

* 'Mémoire sur les Urédinées et les Ustilaginées.' (Ann. d. S. nat., 4 sér., t. ii, 1854, pp. 77—193.)

1. In the autumn the common house-fly is subject to a fatal disease, which occurs epidemically, and disappears in the course of the following winter.

2. This disease is characterised by the development of a microscopic *fungus—Empusa muscæ*—in the interior of the body of the fly; the death of the insect is caused by the vegetation of this parasitic growth.

3. The disease is manifested externally, at first by a degree of slowness in the motions of the flies; at this stage, the fluid (blood) which occupies the interspaces between the viscera increases greatly in amount, and is found to contain innumerable fat-drops, which give it a milky appearance.

4. Innumerable very minute free cells make their appearance in the blood, having a very delicate, at first indistinguishable membrane, and granular contents.

5. These cells rapidly attain to a very considerable size, and when uniformly nourished retain their original spherical or ovoid form; but usually, owing to the unequal supply of nutriment, probably referable to the circulation of the blood, they assume the form of longer or shorter tubes.

6. The globular or tubular forms exhibit towards water and other reagents, precisely the same reaction as do cells originating in free cell-development. When placed in water they swell out considerably, and even the most elongated tubes soon acquire a globular figure, their contents at the same time coagulating and exhibiting large oil-drops; the membrane, in the younger stages, is dissolved altogether in the water; older cells merely burst at one end, through which the contents escape.

7. A few hours before death the fly ceases to exhibit any spontaneous movement; the abdomen becomes much distended by the increased quantity of blood-fluid, and in consequence of the innumerable, free, occasionally very large fungus-cells floating in it.

8. At this time all the fungus-cells have regained the ovoid form, probably owing to the uniform nutrition which they receive when the circulation of the blood ceases; at one, more rarely at two points of these cells, cæcal processes are formed, which elongate in a root-like manner, interlace with each other, and throw out branches. Many thousands of them in this condition surround the viscera without penetrating into their substance; nevertheless, it is soon apparent that the parasitic fungi are nourished at the expense of the tissues.

9. After death, the body of the fly exhibits peculiar contortions and extensions of the legs, wings and abdomen;

the proboscis is protruded, and firmly adheres by suction to the wall, &c.; in consequence of their adhesion by this part, and by the outstretched legs, the dead insects remain attached to the surface, just as if they were still alive; their bodies dry completely, and become excessively friable.

10. The blood-fluid, as well as the viscera, are gradually consumed by the parasitic Empusa, whose radical extremity continues to elongate, whilst the opposite end expands into a clavate head. Owing to the development of the parasitic growth, the abdomen of the insect continues to enlarge more and more, and the rings of the abdomen to separate from each other.

11. Eight to ten hours after death the delicate membrane by which the segments are united, is perforated by the clavate extremities of the *Empusa*-cells, which then appear on the exterior, forming white zones, which continue to increase in width, between the rings of the abdomen.

12. The clavate exterior extremity of the fungus-cells grows rapidly, and by the formation of a dissepiment at the lower (internal part) becomes divided into two, so that the fungus now consists of two cells—a radical and a peduncular.

13. The peduncular cell is elongated at the apex into a short, cylindrical process, which soon expands into a vesicular form, is filled with the plasma which continues to flow into it, and separated from the lower portion by a transverse dissepiment. In this way is formed the unicellular *spore*, which soon assumes a bell-shaped form. The *Empusa*, consequently, is a typical, *tricellular* plant.

14. From the elastic pressure exerted by the peduncular cell, the spore is projected to the distance of about an inch. The scattered spores form a white dusty area around the dead flies, and adhere firmly to their wings and legs.

15. The spores are often found enclosed in vesicles, and thus become assembled into little masses; the origin of these vesicles has not yet been ascertained with certainty.

16. Success has not yet attended attempts to effect the germination of the spores, either in water or moist air, or by artificially affixing them upon or introducing them into the interior of living flies.

17. If a fly dead of this disease be placed in moist air, fungi are developed upon it, but belonging to forms which, manifestly, have no genetic connection whatever with *Empusa* (*Penicillium*).

18. At present, consequently, there is no evidence whatever to show the relation of the *Empusa*-spores to the appearance of this *fungus* and of the disease, whilst the

chemical and optical relations of the innumerable, free cells in the blood-fluid, the absence of any special, self-extending *mycelium,* and especially the entire history of the development, appear to favour the notion of the origination of the *Empusa*-cells in a free cell-development in the morbidly altered blood.

19. This disease of the fly, so far as at present known, finds its only analogue in the epidemic disease of the silkworm termed "*Muscardine,*" which has been ascribed to an entirely different *fungus—Botrytis Bassiana.*

20. But until the "Muscardine" shall have been subjected to renewed and thorough investigation, no accurate judgment can be arrived at with respect to the relation of the two diseases to each other, a few observations rendering it doubtful whether the *Botrytis Bassiana,* or, more probably, a fungus allied to the *Empusa muscæ,* may not play the principal part in this disease.

The above account of *Empusa muscæ,* the author observes, was in print before the appearance of M. Tuslasne's Mémoire sur les Urédinées et les Ustilaginées' ('Ann. d. Scien. Nat.,' 4 sér., tom. ii, pp. 77—193, 1854); in which paper an account is given of the development of numerous "smut-fungi," which differs from all that was previously known with respect to the development of these microscopic organisms, and which, moreover, would seem calculated to throw a new light upon the origin of certain morbid phenomena.

In the germination of this class of fungi, for instance, the peculiar, uni- or multi-cellular hypnospores, containing much oily matter, and having a double membrane, are not at once and directly developed into a new *mycelium,* but the *endosporium* breaks through the outer membrane (*cuticula*) of the spore and elongates into a short tube, which in length but slightly exceeds the spore; this germinal tube, *tube-germe, promycelium* (which would appear to correspond with the *prothallium* of Mosses or the *pro-embryo* of Ferns), then bears a considerable number of *secondary sporidia,*—in the "smut" of wheat (*Tilletia caries*) 8—10 in number,—of a long-fusiform, *fusidium*-like shape, united in pairs by a transverse band, and consequently altogether dissimilar to the peculiar, primary spore. These *sporidia* soon detach themselves from the germinal tube, whose entire protoplasm was employed in their formation. These secondary spores even do not usually appear directly to throw out a *mycelium,* but first become elongated into peduncles, supporting at the summit reniform cells—*tertiary sporidia.* At present it has not been observed

whether the tertiary *sporidia,* when they have reached a wheat-plant, are directly developed into the "smut-fungi" from which are produced the well-known (primary) *Tilletia*-spores, and thus close the entire cycle of a complicated alternation of generations. (These results of M. Tulasne's observations have been confirmed by H. Kuhn, of whose merits as an observer Cohn speaks highly, and also by himself).

These observations indicate, at any rate, that in the above class of parasitic fungi each spore does not immediately produce a new plant, but in the first place a considerable number of spores of another form and structure, from which only the true *mycelium* is developed. A very few spores, therefore, are sufficient to produce a vast number of *fungi,* and in this way to destroy whole ears of corn.

The author's conclusions respecting the development of the *Empusæ* in the fly were based principally upon the fact, that their origin could in no way be explained according to the views at present prevailing in science, since neither the true spores of the *fungus,* which are never met with there, could penetrate directly into the abdominal cavity of the diseased animal, nor could any *mycelium,* in any way originating, form spores which might have germinated upon the surface of the fly. Since, moreover, the youngest conditions of the *Empusæ,* which I have observed, he says, in the fly's blood, were far smaller than and of an entirely different structure to the characteristic spores, and were also from the first present in vast numbers, the only conclusion left to be drawn was that they had arisen in free cell-development. M. Tulasne's discoveries have now, however, at any rate, shown us the possibility of another mode of origin by means of the spores. It might be supposed that in the interior, or on the outer surface of a fly, a few, and therefore readily overlooked, *Empusa*-spores may have become developed, and at first, like the "smut-fungus," may throw out short germ-tubes, which afterwards, in some way, produce a great number of smaller, differently formed cellules (*sporidia*), which subsequently grow into complete *Empusæ.* In this way, at all events, may be explained the multitudinous appearance of free, minute *Empusa*-cells, without any necessity for the entrance of as many *Empusa*-spores, or of a spreading mycelium.

Although M. Tulasne's researches indicate the possibility of such a mode of development, also, in the genus *Empusa,* it must be allowed that it has not been proved that such a process really takes place. In opposition to such an assumption we have, he says, not only the want of all the supposed

intermediate stages, but, in particular, also are the anatomical, physical, and chemical conditions of the younger *Empusa*-forms, which appear in all respects to present the characters, not of spores, but of young, newly formed cells. Further researches are requisite to bring this question to a satisfactory determination.

A Synopsis of the British Diatomaceæ. By WILLIAM SMITH, F.L.S. London: Smith and Beck, and Van Voorst.

THOSE microscopists who are working at the British Diatomaceæ will rejoice to know that the second volume of Professor Smith's work is at last completed. They have now a complete work to which they may refer for information with regard to all forms of British Diatomaceæ. This second volume is a worthy companion of the first. The descriptions of the species are ample, the notes are valuable, and the plates, if possible, exceed the last in their beauty and accuracy. With regard to the latter, we are sure that Professor Smith would be amongst the first to acknowledge how greatly the value of his work is enhanced by the unrivalled skill with which Mr. Tuffen West has delineated the beautiful objects he has described.

Since the publication of the first volume in 1853, many new species belonging to genera there described have been discovered; and although Professor Smith has given a list of those in an appendix, with references to the works in which they are described, mostly in our own Journal, yet every one will be glad to hear that he intends publishing a Supplement. Many of the new species require criticism and revision, and a Supplement will afford Professor Smith an opportunity of not only hauling over the contributions of his friends, but some of his own.

The Introduction to the present volume contains some interesting remarks on the history of the Diatomaceæ. The first section takes up the question of reproduction. Little seems to be added as to the nature of this process, since the first observations of Mr. Thwaites. The fact of the production of the spore as the result of conjugation has, however, been observed up to the present time in no less than thirty-two species, belonging to seventeen genera. Of these, Professor Smith gives a list. On the modifications of this process, Professor Smith makes the following remarks:

"I. We have two parent-frustules, and two sporangia as

the result of their conjugation. This mode is seen in *Epithemia*, *Cocconema*, *Gomphonema*, *Encyonema*, and *Colletonema*.

"II. From the conjugation of two parent frustules we have a single sporangium. This occurs in *Himantidium*.

"III. The valves of a single frustule separate; the contents, set free, rapidly increase in bulk, and finally become condensed into a single sporangium. This may be seen in *Cocconeis*, *Cyclotella*, *Melosira*, *Orthosira*, and *Schizonema*.

In *Melosira nummuloides*, *M. Borrerii*, and *M. subflexilis*, the second valve of the conjugating frustule is rarely found united to the mucus surrounding the sporangium, the conjugation taking place only in the last frustule of the filament; but in *Melosira varians* and *Orthosira orichalcea*, conjugation taking place throughout the entire filament, both valves are usually found adherent to the sporangium or its surrounding mucus.

"IV. From a single frustule, as in the last method, two sporangia are produced in the process of conjugation. This takes place in *Achnanthes* and *Rhabdonema*.

"On the whole, the facts at present within our knowledge seem fully to warrant the conclusions that the conjugated state of the Diatomaceæ is the first step in the reproductive process of these organisms, and that the sporangial products of this condition become the parents of numerous young frustules, destined to renew the cycle of phenomena which accompanies the life and growth of the species from which the sporangia have themselves originated."

In the next section Professor Smith enters upon the question of the nature of the Diatomaceæ, and successfully, we think, vindicates their claims to be regarded as members of the vegetable kingdom. Although he does not refer to any experiments, he states that the Diatomaceæ give out oxygen from their tissues, and take up carbonic acid gas. If this has been proved by experiment, we should regard it as conclusive of their vegetable nature, as the performance of these functions seem to be the most universal condition of the existence of plants of which we have any knowledge.

In the concluding sections Mr. Smith treats of the determination of species, and of the distribution and uses of the Diatomaceæ. We can only repeat that this volume fully maintains the reputation of the first, and express our conviction that the whole work is one of the most important contributions ever made to microscopic natural history in this country.

Hints on the Pathology, Diagnosis, Prevention, and Treatment of Thoracic Consumption. By J. C. Hall, M.D. London: Longmans.

In the ordinary course of noticing works interesting to those who use the microscope, we are not often called on to bring before our readers works devoted to the practical departments of medical science. At the same time, we are convinced that this does not arise from any deficiency in the microscope; but from the want of skill in the use of it amongst those who practise the medical profession. In an art so dependent on a correct appreciation of facts only known to exist by sight, it must be evident that the microscope will become essential to all conclusive investigations, and that scarcely any correct diagnosis will be made without its aid. We notice, therefore, Dr. Hall's book, because in the first place we think he has made good use of the microscope in the diagnosis of disease, and in the second place because he has been kind enough to put one of the plates, illustrating his work, at our disposal (Pl. X.) We shall not, however, criticise Dr. Hall's book, but let him speak for himself on the subject of the use of the microscope in the diagnosis of tubercle. He says:

"Since the publication of the former editions of this work the microscope has thrown no little light on the true nature of tubercle, which may, in almost every instance, be regarded as an exudation of proteine material rapidly passing into the solid form, and never advancing beyond the lowest grade of development. In examining tubercles from the lungs, it has ever appeared to me that considerable difficulty must be experienced in arriving at a correct histological definition; for no little risk is of necessity incurred of regarding half-destroyed tissues as new products, and hence one reason for the different opinions expressed by different writers on this subject. With regard to the seat of tubercle in the lungs, it may be stated that tuberculous matter is deposited primarily on the free surface of the lining membrane of the air-vesicles, the inter-vesicular passages, or the lobular bronchi. Dr. Clark, in his remarks made to the Pathological Society on the preparations illustrative of the seat of tubercle, shows that the deposit of tubercles takes place primarily on the free surface of the lining membrane of the air-vesicles, the inter-vesicular passages, or the lobular bronchi—that it extends to the walls of the air-vesicles, the areolar tissue around the blood-vessels and bronchi; and between the lobules only at an advanced period of growth, when such retrogressive changes have set in as involve destruction of the structural elements of the lung; and that it does not occur *indifferently* at any point external to the blood-vessels.

"There are two principal varieties of tubercle known as *gray tubercle* and *yellow tubercle*, of which the admirable delineations of Mr. Tuffen West in the plate convey to the eye a correct representation. The tuberculous matter for the most part assumes a spherical form, its origin being in a blastema exuded from the adjoining capillaries, which, effused in a fluid

condition, infiltrates the tissue. The elements of tubercle, according to Wedl, Vogel, Lebert, Gluge, Rokitansky, and as far as my own observations enable me to judge, may be described as—

"(*a*) Molecules, assembled in superimposed layers, some too minute to be measured.
"(*b*) Flocculent masses, consisting of proteine bodies, only seen when the tubercle is carefully spread out.
"(*c*) Rounded or oval nuclei, imbedded in a hyaline matrix, with scattered molecules.
"(*d*) Flattened angular, granular corpuscles, rarely with a distinct nucleus, which become transparent on the addition of acetic acid.
"(*e*) Cells, occasionally elongated, with distinct nuclei.

"*Gray tubercle* is of uniform consistence, toughish or soft, compressible, and of a pearly gray colour; it is composed essentially of 'a basis substance, which is solid and homogeneous, and serves as the uniting medium of certain corpuscular elements;' such as oily-looking granules, nuclei, and a few cells; the elements of the tissue in which it is deposited may also frequently be seen. I have never discovered any vessel in separate tubercles, although when several are aggregated together, in the interspaces some traces of those belonging to the tissue may be observed.

"*Yellow tubercle*, which usually forms in larger masses than the gray, varies in colour, though generally of a whitish-yellow hue. These tubercles are from the first opaque, of a cheesy consistence, containing a large abundance of fine proteine molecules, among which may be detected the elements of gray tubercle, shrivelled, indented, and wrinkled, and of a yellowish lustre. The relation of the two varieties of tubercle to each other is a point of considerable interest; and Laennec without doubt was right when he taught that gray tubercle sooner or later is converted into yellow tubercle. This undergoes two metamorphoses of very great importance to the practising physician; *one is that of softening—the other that of cretification.* That yellow tubercle should be thus regarded as a secondary form of gray tubercle is generally correct, and also in strict accordance with the fatty metamorphoses of normal and newly formed elements; but it has been suggested with some probability that the remains of the proteine compounds, which have not been used in the formation of the organic elementary parts, may at once undergo fatty degeneration; and, consequently, that it is not absolutely necessary that the yellow tubercle should have previously been of the gray kind."

Further on, Dr. Hall gives precise directions for examining the expectorated matter in cases of disease of the lungs:

"To form a correct opinion of the nature of the sputa submitted to us for examination requires no little time and study. It obliges a thorough knowledge of the appearances of the secretion natural to the mucous and salivary glands, the epithelium of the mouth, of the fauces, and the pharynx, and the results of the varied morbid processes which may take place in the several parts. Portions of fungous vegetations, which are so frequently present at the back of the mouth and in the matter secreted by the tonsils, are very often seen in the expectoration, mingled with the remains of the food that has been taken; such as muscular fibre, starch, oil globules, various vegetable and animal substances, &c. It must not, therefore, hastily be concluded that everything we see in the sputa, under the microscope,

comes from the air-tubes. And, again, in examining the expectoration in certain trades—such, for example, as the grinders of Sheffield—various small particles of stone and of steel may be readily detected. The appearances vary a good deal, however, in these men with the time of the day at which the expectoration has been coughed up, and whether or not they have been working within a short period at the wheel. Pus, blood-corpuscles, claws of Echinococci, and portions of hydatids, are sometimes present, and in the more advanced stages of pneumonia numerous large cells containing oil globules will be seen, together with many finely granular cells, not very unlike pus globules, but which, on the addition of acetic acid, do not exhibit the presence of central bodies. Sometimes the sputa contain small fragments of pulmonary tissue, frequently distinct and well defined, but which are easily overlooked without a good deal of care. The small white calcareous masses which are not unfrequently present in the sputa in cases of arrested thoracic consumption, and of which Mr. Tuffen West has given a good illustration in the plate, as well as of some crystals of cholesterine, are best examined by mounting them as opaque objects, on a black ground, and looking at them through an inch object-glass. Sometimes in the cheesy matter found so largely in tuberculous masses we may not be able to detect crystals of cholesterine; it is better then to place a little bit of the mass on a slide, and to add a small quantity of alcohol. As this evaporates, crystals of cholesterine gradually form, and may then be easily examined under the microscope. They are very beautifully seen by polarized light. If the calcareous masses to which reference has just been made be placed in a watch-glass, and tested with a little acetic acid, they will dissolve with effervescence, demonstrating the presence of a carbonate. If to one part of the acetic acid solution an excess of ammonia be added, a precipitate of phosphate of lime takes place, and a little of a solution of oxalate of ammonia added to the other portion will detect the presence of lime."

The following remarks apply to the character of the sputa in true cases of tubercle of the lungs. The appearances described in the following paragraphs are illustrated in Plate X of the present volume of the Journal.

"The first kind of expectoration observed in thoracic consumption is frothy, and is characteristic of irritation. So far as my own experience goes, it does not enable us to arrive at any correct conclusion as to the existence of tubercle when placed under the microscope; and many of the appearances may arise from other causes. After a longer or shorter period, as the disease may be impending or established, the expectoration becomes gelatinous, rather transparent, and resembles a solution of isinglass. This expectoration is generally brought up in a morning in the dressing-room, and scarcely noticed by the patient. It consists of a transparent and very tenacious semi-fibrillated matrix, in which we may see imbedded oily matter, molecules, granules, and corpuscles. This kind of expectoration may often be seen in various forms of pulmonary congestion. The investigations I have made in numerous cases of phthisis enable me to conclude with certainty that we have, in looking at this kind of expectoration, a diagnostic guide of very great practical importance; for where there is no special tuberculous tendency the corpuscles are of one uniform kind, but when the deposit of tubercle has taken place or is impending the corpuscles are of various forms and sizes. Some are ovoidal, some spherical, and resist the action of acetic acid; others are abruptly defined, obscurely granular or nebulous, requiring the application of reagents to render their

nuclei apparent. Others, again, are compressed and elongated; another set may be seen of a spherical form, which are filled with granules of fat or pigment, and these are often in process of disintegration; and, lastly, corpuscles may be seen with depressions, from which nuclei have been extruded. The first kind of corpuscles, Dr. A. Clark considers to consist of very young epithelial cells and extruded nuclei; the other varieties are unquestionably diseased epithelial cells, in various stages of degeneration. The jagged outlines of the corpuscles (to which allusion is made in the case described pp. 46 and 47), is a point of great interest to the practitioner, and almost certainly diagnostic of phthisis. Dr. C. Radclyffe Hall has drawn attention to the appearance in the sputa, of *enveloped blood-corpuscles*, at the commencement of thoracic consumption. In a great majority of the cases in which I have examined the sputa this microscopic hæmoptysis has been evident, even when to the naked eye there was no trace of blood, and the opinion of this physician, that this appearance is seldom absent in cases of the disease in which the more obvious expectoration of blood is wanting, is strictly in accordance with what I have observed.

"The next kind of expectoration is met with at a more advanced stage of thoracic consumption. A highly characteristic example is given (pl. i, fig. 6) of this flocculent sputa, in which will be seen a large piece of the curled elastic tissue surrounding the pulmonary vesicles. The expectoration was obtained from Sarah Ann Chambers, aged 18, admitted during the month of October, 1856, under my care, at the Sheffield Public Dispensary, with signs of softening at the apex of one lung. It is at the period of the formation of these excavations in the lung that I most frequently observe the elastic tissue forming the areolæ of the air-vesicles, partially obscured by masses of molecular matter in which tubercle-corpuscles may be seen, and it then becomes an important aid to the formation of a correct diagnosis. I may observe that the elastic tissue shown in the plate is exactly a quarter of the actual size of one of the pieces in the preparation put up by me, from which Mr. Tuffen West's drawing was made. The pus globules, shrivelled cells, disintegrated nucleated cells, &c., &c., found in the sputa of this patient, will be described at the end. I have never yet met with a case in which I discovered, with the microscope, the elastic tissue of the lungs in the absence of all other symptoms indicative of thoracic consumption. Such a case, however, has occurred, in which that accomplished physician, Dr. Bennett, after a careful examination with the stethoscope, could not detect any physical sign of consumption. The case was seen with W. T. Iliff, jun., Esq., of Kennington. Professor Bennett says, 'the chest was well formed; careful percussion and auscultation elicited positively nothing; the percussion note was normal and equal on both sides; the respiratory murmurs were normal, and there was no increase of vocal resonance.' There was cough and muco-purulent expectoration. This patient, a lady, aged 23, had an impression she was in the habit of spitting up fragments of her lungs. Some of them were examined by Dr. Bennett, Mr. Quekett, Mr. Rainy, and Dr. Beale, all of whom agreed as to the fact of the expectorated matter containing portions of human lung. After a time the physical signs of the disease became more clear, and on examination after death extensive tuberculous disease of both lungs, with cavities in their apices, was found. This case has fully impressed Professor Bennett with the importance of a microscopic examination of the sputa whenever the symptoms and a suspicion of thoracic consumption exist, without any clear evidence derivable from auscultation being present; and when such signs are present as lead to the conclusion that a cavity is just forming, microscopic appearances of the sputa, such as are shown on the sixth figure of the

first plate, afford, I am certain, no little evidence confirmatory of our opinion.

"At a more advanced period of the disease, when there is a large cavity, the sputa is little more than pus, mucus, large granulous cells, and sometimes portions of opaque tubercle, and confervoid vegetations."

Dr. Hall's volume is small, and is written in a manner which gives it a claim to be read by all who are interested in the study of tubercular disease of the lungs.

Ueber die Entwickelung und den Bau des Säugethierzahns. Von Dr. Adolph Hannover.

('Verhandlungen der Kaiserl, Leopold-Carolinschen Akademie,' vol. xxv, p. ii.)

In this beautifully illustrated memoir, Dr. Hannover contributes much interesting information with regard to the histology of the dental tissues in the *Mammalia* generally; but we suspect that both by the author, and by the scientific public, the pith of the essay will be considered to lie in the views respecting the development of the teeth, whose exposition occupies so large a portion of it. It is to these, therefore, that we shall chiefly direct the reader's attention in the course of the following critical analysis. Dr. Hannover commences his work thus:

"The dental sac of *Mammalia* contains four elements, which, without coalescing, lie in contact, and are distinguishable by their very peculiar structure. Below, on the bottom of the sac and coalesced (verwachsen) with it, lies a soft body, which at a very early period acquires the form of the crown of the tooth. This body is the dentine-germ (dentin-keim); by a process which we shall call 'dentification' it becomes dentine, a substance characterised by the branched tubules which it contains. The dentine-germ is immediately covered by the enamel-germ: this consists of cells (the enamel-cells), on the whole arranged perpendicularly, which are at first very soft, but subsequently, by calcification, become solid columns, and constitute the hardest substance of the tooth—the enamel. Most externally in the dental sac lies the cement-germ, which, by a process of ossification quite analogous to that which takes place in bone, is changed into cement, characterised by its osteal lacunæ and medullary canals. The cement-germ, however, lies in immediate contact neither with the enamel nor with the dentine, but is separated from them by a peculiar membrane, not yet sufficiently distinguished; this carries upon its inner surface the enamel-cells, which are disposed perpendicularly upon the dentine, and consequently it separates the cement-germ from the enamel-germ; but where the enamel-germ ceases it separates the cement-germ from the dentine-germ. We shall term this membrane the *membrana intermedia;* in the complete tooth it appears as the *stratum intermedium.*" (p. 3.)

The careful study and collation of different passages in Dr. Hannover's work show that his dentine-germ is the dental papilla of English writers; that the enamel-germ is the *membrana adamantinæ*; that his *membrana intermedia* is the layer of what Nasmyth ('Researches on the Development, &c., of the Teeth,' 1849, p. 107) describes as "oval cells," seated on the deep surface of the stellate tissue of the enamel-organ; and that his cement-germ is nothing more than the stellate tissue of the enamel-organ, which he confounds with the vascular "actinenchyma" or peculiar connective tissue of the proper wall of the dental sac.

Under the head of the development of the enamel, Dr. Hannover offers us nothing new; but repeats, without bringing forward new evidence, and as if it had never been disputed, the old view that the enamel is produced by the direct calcification of the columnar cells of the *membrana adamantinæ*. Nor can we find any essential difference between Dr. Hannover's theory of the formation of the dentine and that advocated by Professor Kölliker and others, except that he denies the existence of a *membrana preformativa*, and affirms that—

"This so-called membrane is, in my opinion, nothing but the outermost layer of dentine-cells, in which dentification has just commenced." (p. 12.)

How this can be reconciled with the unquestionable facts that the *membrana preformativa* can be traced with great ease, uncalcified, on to the primary cap of dentine, and that it is a structureless membrane in which no trace of cells has ever yet been detected, we know not; but we are inclined to suspect that Dr. Hannover has never seen the true *membrana preformativa*.

As regards the *membrana intermedia* we are desirous to do Dr. Hannover no injustice in endeavouring to explain, what seems to us to be, his erroneous view of its functions and homologies in the adult tooth, and we will therefore cite his account of it at length.

"4. *Membrana intermedia.*

"I have bestowed this name upon a membrane which has not as yet received sufficient attention.* It is a fine and delicate membrane, which must not be confounded with the membranous expansion of the enamel-

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* Kölliker has, perhaps, figured it in his 'Mikroskopische Anatomie,' p. 99, fig. 211 *d*, without, however, recognising its true nature. What Tomes has termed "basement membrane" appears to have been not exclusively the *membrana intermedia*.

cells, and which lies within the cement-germ, between it and the enamel-cells. It appears in transverse sections of the germ as a fine white line; is a tolerably firm and opaque membrane, and consists of a structureless mass, in which very numerous small, round or oval, angular or pointed nuclei, without distinct nucleoli, are imbedded. The boundary towards the cement-germ is sharp and linear, and the cells of the cement-germ are pressed against it (fig. 11 *a*). The boundary towards the enamel-cells, which lie upon the opposite surface, is also well defined (fig. 19 *a*). The enamel-cells may be detached with tolerable ease, whilst it is only with difficulty that the *membrana intermedia* can be separated from the cement-germ. It is, therefore, best examined in connection with the cement-germ, and, indeed, in the teeth of the new-born infant. In order to observe the attached enamel-cells, the membrane may be folded, because in thin sections the enamel-cells easily fall off.

"The thickness of the *membrana intermedia* differs considerably in dental sacs of different ages. In the persistent teeth of the new-born infant it is hardly visible to the naked eye; in their milk-teeth it is very easily recognisable, in consequence of its white colour, and has considerably increased in thickness; it is thickest, perhaps, about the constricted part or neck of the dentinal germ, with which it is also more intimately connected. Fig. 19 *a* shows its thickness in the deciduous molar of a new-born infant.

"The *membrana intermedia* does not belong to the crown or the enamel alone, for it is continued uninterruptedly upon the fang, here separating the dentine from the cement, and, as in the crown, lying upon the inner surface of the cement-germ. However, I have not been able to demonstrate it here in an isolated form, because, immediately on the formation of the outermost layer of dentine, it coalesces with it, and can be recognised only from its appearance in the complete tooth, where we shall find it as the *stratum intermedium*. If we consider the *membrana intermedia* as a whole, it may be regarded as a sac-like structure which is inclosed within the dental sac, so that the cement-germ is situated between the *membrana intermedia* and the dental sac; perhaps the membrane becomes reflected over the inner surface of the dental sac."

Now there can be no doubt as to the existence of this layer. It was, as we have seen, described by Nasmyth; it is, as Dr. Hannover justly states, figured by Professor Kölliker; and we have repeatedly seen it ourselves without feeling inclined to lay any very particular stress upon its existence. If there is any advantage in calling it *membrana intermedia*, we shall be happy to adopt this term. But we must demur to Dr. Hannover's view of its ultimate fate, as contained in the following passage (p. 110) of his memoir.

"4. *Stratum intermedium*.—The nucleated membrane, which during the development of the tooth is closely united with the cement-germ, and serves for the attachment of the nucleated end of the enamel-cells, and to which we have given the name of *membrana intermedia*, is always sufficiently obvious in the perfect tooth, though much changed. It receives its persistent form only after the enamel-cells are calcified throughout their whole length; since it lies between the enamel-cells and the cement, the ossification of the cartilaginous cement-germ can only take place after the completion of the development of the *membrana intermedia*. Hence in the crown it always separates the enamel, in the root, the dentine, from the cement. Since,

however, the cement-germ as a rule does not ossify, but becomes abortive on the crowns of teeth with conical dentine-germs, the *membrana intermedia* in such crown lies free, and in teeth which have not been worn forms what Kölliker terms the cuticle of the enamel."

Dr. Hannover then goes on to speak of the identity of his *stratum intermedium* with the "persistent capsule" of Nasmyth; and he describes the mode of raising up the membranous *stratum intermedium* in young teeth, by the action of dilute acids, which he states to have been discovered by Erdl in 1843.

Dr. Hannover appears to be unaware that this persistent capsule, or "Nasmyth's membrane," has of late been the subject of special investigation on the part of Professor Huxley, M. Lent, and Mr. Tomes, and therefore he does not attempt to meet the obvious objections which an acquaintance with the known relations of Nasmyth's membrane in the young dental sac would have suggested. Inasmuch, in fact, as Prof. Huxley's statement, that Nasmyth's membrane lies on the inner side of the cells of the *membrana adamantinæ*, between these and the fibres of the enamel, has been confirmed both by M. Lent and by Mr. Tomes, it will probably be admitted to be correct; and consequently the *membrana intermedia* of Dr. Hannover, which lies *outside* the cells of the *membrana adamantinæ*, and is separated by their entire length from Nasmyth's membrane, can have nothing to do with the latter. In fact, we believe that the "*membrana intermedia*" is an entirely transitory epithelial structure, and enters in no way into the composition of the tooth.

We must express the same opinion with respect to the "stellate tissue"—Dr. Hannover's cement-germ. Dr. Hannover, after giving an account of the early changes of the epithelial lining of the dental sac, and the production of the stellate cells, in a manner not essentially different from that contained in Mr. Nasmyth's last work, seems to us to make the mistake which has already been committed by more than one writer on these subjects, of supposing the actinenchyma of the thickened wall of the dental sac to be a later stage of the stellate epithelial tissue—with which it has nothing to do, and from which it is separated by the basement membrane of the dental sac. We have in our possession figures, drawn long ago, of sections of the thickened wall of the dental sac, in all essential respects corresponding with Dr. Hannover's fig. 13; and having worked carefully over the relations of the actinenchyma (which is nothing but such connective tissue as may be met with in any soft young organ), with

the stellate tissue, we venture to speak positively on this question.

If the cement then is really developed within the actinenchyma, as Dr. Hannover describes it to be, the establishment of the fact will simply prove that his "cement-germ" (*i. e.*, stellate tissue of enamel-organ) has as little to do with the cement, as the *membrana intermedia* has with the *stratum intermedium* or Nasmyth's membrane.

It may be worth while, before concluding this notice, to consider in a few words the present state of our knowledge of the development of the teeth.

In an essay published in this Journal some years ago (vol. i, p. 149), Prof. Huxley endeavoured to prove that all the dental tissues, whether cement, enamel, or dentine, are developed beneath the basement membrane of the dental sac, which, on the dental papilla itself, has received the name of *membrana preformativa;* and that the so-called enamel-organ—consisting from within outwards of the *membrana adamantinæ,* the *membrana intermedia* of Hannover, the stellate tissue, and the deep layer resembling the *membrana intermedia,* next the basement membrane of the sac—was to be regarded as a transitory epithelial structure, which has as little connection with the development of the tooth as the various modifications of the epithelium of the root-sheath of a hair have with that of the shaft of the hair.

Evidence was offered, 1st, that the enamel-fibres, from their first appearance, lie beneath Nasmyth's membrane. 2dly. That Nasmyth's membrane is continuous with the *membrana preformativa.* 3dly. That no traces of cells or endoplasts can be discovered within the enamel-fibres nor in the dentine, and that these tissues are not produced by the direct calcific conversion of pre-existing elements. 4thly. That the cement is morphologically the continuation of the enamel, but whether it is or is not developed by conversion from the pulp was left an open question.

The first of these statements has received full confirmation from subsequent observers, including M. Leydig, in his recently published, valuable 'Lehrbuch d. Histologie,' p. 291.

The second assertion has been confirmed by M. Lent, and is not directly controverted in Mr. Tomes's paper on the Development of the Enamel, published in the 15th number of this Journal.

The third statement appears to be justified whenever writers on this question state what they have observed, and not their conclusions from their observations. We are not

aware that any one has as yet absolutely seen endoplasts or their remains in distinctly formed or forming enamel or dentine.

Mr. Tomes, in the excellent essay we have cited, endeavours to prove that Nasmyth's membrane is formed by the union of the ends of the cells of the *membrana adamantinæ,* which coalesce into a membrane; and this view would undoubtedly relieve one of much difficulty in understanding the formation of the enamel, and would bring it nearly into the same category as that of molluscan shell; but until it can be shown that Nasmyth's membrane is not continuous with the *membrana preformativa,* and is not an alteration of it, we must adhere to the view that the enamel is, like the dentine, formed under the *membrana preformativa.* Hitherto no one has attacked this side of the argument, nor has the evidence derived from the obvious continuity of the *membrana preformativa* over the whole surface of the teeth in fishes and *Amphibia* been in any way shaken. T. H. H.

ZOOPHYTOLOGY.

Class. Polyzoa.

Sub-order. *Cheilostomata.*

Fam. *Salicornariadæ.* Busk.

Gen. *Onchopora,* Busk. ('Quart. Journ. Micr. Sc.,' vol. iii, p. 320.)

1. *O. Sinclairii,* n. sp. Busk. Pl. XV, figs. 1, 2, 3.

Cells ovate, ventricose, attenuated at the bottom, slightly keeled in front, the upper part of which is occupied by a scutiform area, having in the centre a lunate pore; mouth large, sub-orbicular, the lower lip nearly straight; surface smooth; ovicell raised, globose, large, with a prominent central umbo, from which costæ radiate on the sides and summit.

Hab. New Zealand, *Dr. Sinclair*, *Dr. Lyall.*

The characters of the genus Onchopora will require to be altered to admit the present form, which is obviously too closely allied with those previously included in it, and especially with *O. mutica,* to allow of their being separated. The alteration will consist in the omission of the last part of the character given as above, or that referring to the ovicell, which in the present species is very large and peculiarly marked.

The polyzoary of the present species, which has something of the habit of a *Salicornaria,* is constituted of cylindrical branches of various lengths and usually dividing dichotomously. The whole forms a more or less dense rounded tuft.

2. *Lepralia,* Johnst.

1. *L. thyreophora,* n. sp. Busk. Pl. XV, figs. 4, 5.

Cells ovate, upper half in front occupied by a scutiform area, in the centre of which is a lunate pore, and on either side a single row of punctures (?) which also extends across the front of the cell immediately below the mouth, which is rounded above with a straight lower lip; ovicell lofty, rounded, faintly punctated.

Hab. New Zealand, *Dr. Sinclair.*

This Lepralia, which is parasitic upon *O. Sinclairii,* in some respects resembles *L. Malusii* (B. M. Cat., pl. 103), differing from it, however, in its having a distinct scutiform area on the front of the cell, and in the arrangement of the apparent perforations or puncta, which exist only around the margin of the scutiform area and across the upper border of the cell, whilst in *L. Malusii* the entire front of the cell, except in the centre, is punctated.

Another species with which the present might also be confounded, and from which it appears to differ only in the absence of oral spines—is the *Escharina cornuta* of D'Orbigny ('Voy. à l'Amer. occid.,' plate v).

2. *L. Cecilii*, Audouin, Exp. I, p. 239. Pl. XV, figs. 6, 7.
Savigny, Egypt, pl. ix.

Cells ovate, with a central umbo, surface punctate; mouth rounded above, with a straight lower lip, in the middle of which is a narrow sinus; ovicell raised, surface granulose.

Hab. Jersey, *Mrs. Buckland.*

This large and beautiful species, for which the British Fauna is indebted to Mrs. Buckland, corresponds so closely with Savigny's figure of *L. Cecilii*, that there can be little doubt of the two being identical.

Sub-kingdom. CÆLENTERATA.

Class. HYDRAZOA.

Order. *Hydroida.*

Fam. *Sertulariadæ.*

Gen. *Cryptolaria*, n. g. Busk.

Cells completely immersed in a cylindrical polypidom, composed of numerous tubes.

1. *C. prima*, n. sp. Busk. Pl. XVI.

Sp. unica.

Hab. New Zealand, *Dr. Sinclair.*

This curious Sertularian appears to constitute a peculiar type of the family to which it belongs.

The specimen from which the description and figures were made, collected by Dr. Sinclair in New Zealand, and now in the British Museum, is about six inches high, and consists of a single central stem or rachis, with alternate branches on either side in the same plane, and which become shorter as they approach the summit. The lower part of the rachis or stem is toothed on each side, the teeth evidently representing the roots of branches which have been broken off. Towards the lower part of the pinnate portion, one or two small branches also simply pinnate may be seen springing from the main stem.

The stem and branches are composed of small tubes; and the cells are completely immersed among these tubes; the mouth even, being depressed below the surface, and presenting itself in the upper part of an elongated pit, surrounded with a raised border, which arches above the mouth of the cell.

The cells are disposed in longitudinal series, one above the other—but alternate with each other in the contiguous series. The mouth of the cell is contracted, circular, and simple.

On a New Species *of* Bugula. By Joshua Alder, Esq.

Bugula turbinata, Pl. XVII, figs. 1—4.

Polyzoary orange-coloured or yellowish, paler when dry; one to two inches high, forming an ascending spiral, the branches dividing dichotomously, truncated at top, and arching outwards. Cells in two to five series, elongated, the aperture reaching nearly to the bottom; a single erect spine at each upper angle. Avicularia of two sizes, those on the outside moderately large, with a rounded head, and a short back abruptly bent at the point; situated on the upper part of the margin of the cell; inner avicularia small. Ovicapsules subglobose, with a rim rising into a peak in front.

Cellularia avicularia, Pallas, 'Elench. Zooph.,' 68 (?).
Gosse, 'Ramb. Dev. Coast.,' p. 195, t. x.

This species has hitherto been confounded with *Bugula avicularia,* to which it bears a strong resemblance, but is nevertheless quite distinct. In its mode of growth it is rather more robust than that species, and may readily be distinguished from it by the number of cells increasing to three, or occasionally even to five longitudinal rows in some of the branches; in *B. avicularia,* there are never more than two throughout. On examining the two kinds microscopically, other differences are found. The cells in *B. turbinata* have invariably only a single large spine on the outer angle; *B. avicularia* has two spines, as correctly represented by Professor Busk,* though the smaller one has been frequently overlooked. The avicularium is rather smaller in *B. turbinata* than in *B. avicularia,* and has the head more rounded, and the beak much shorter and more abruptly bent at the point (fig. 4). It is also set higher up on the margin of the cell, frequently close below the spine. The ovicapsule in this species is smaller, and has a border generally rising into a peak in front.

The only published figure of this species that can be recognised with certainty is that of Mr. Gosse, in his interesting 'Rambles on the Devonshire Coast,' where it is well described under the name of *Cellularia avicularia.* The magnified figures G, H, pl. xxxviii of Ellis's 'Corallines,' would seem to represent this species, having only a single

* 'Catalogue of Marine Polyzoa,' pl. liii.

spine on each angle of the cell, but the small figure (7) is more like *B. flabellata,* to which it has been usually referred. Pallas describes his *Cellularia avicularia* with three to five longitudinal series of cells, and a single spine at each upper angle; characters which taken together only belong to *B. turbinata,* and the general accuracy of his descriptions favour the supposition that he had this species in view; his var. β being probably *B. flabellata,* to which *Crisia flustroides* of Lamouroux, and *Flustra angustiloba* of Lamarck, may also be referred, though the former author describes only a single spine at each angle of the cell: this is likewise the case in Dr. Johnston's description of *Flustra avicularia,* but his figure more correctly shows two or three spines on each side. The *Cellularia avicularia* of Van Beneden is evidently *B. flabellata.*

B. turbinata appears to be quite as common on the British coast as *B. avicularia,* if not more so. It occurs principally within tide-marks, or in shallow water. The finest specimens I possess were got under stones at low-water mark in the island of Herm. They were of a deep orange colour when alive. I have met with it at Guernsey and in the Menai Straits, and have had it sent from Falmouth by Mr. Cocks. Mr. Hincks informs me that it is the common species on the Devonshire and Yorkshire coasts; and Mr. Busk has favoured me with the examination of a specimen sent from Tenby by Mr. Dyster. It has not yet occurred on the Northumberland coast, nor can I trace it into Scotland, but it would be premature at present to fix any limits to its range.

On some New British Polyzoa. By the Rev. T. Hincks.

The new British Polyzoon which I am about to describe is, in many points, so nearly related to the well-known *Scruparia chelata,* that I have determined to rank it in the same genus with this species, although the generic character, as given by Mr. Busk in his 'Catalogue,' must be revised to allow of its admission.

Polyzoa Infundibulata.

Sub-order. *Cheilostomata.*

Fam. *Scrupariadæ.*

Gen. *Scruparia* (Oken).

Polyzoary erect, branching, subcalcareous; cells clavate; apertures on one aspect, oblique, subterminal.

S. clavata, Hincks, n. sp. Plate XVII, figs. 5, 6, 7, 8.

Cell slender, elongate, enlarged upwards, tapering off below; aperture subterminal, oval; branches given off from the back of a cell; ovicelligerous cells placed back to back with the ordinary cells.

Polyzoary sparingly branched, the branches originating from the back of a cell; cells ovate-elongate above, and tapering off below, each one springing from behind the aperture of another, and attached to it by a somewhat cordate expansion of the base; aperture oval, small as compared with that of *S. chelata*, and not marginated. The position of the ovicelligerous cells is very peculiar. They are (generally) attached to the back of the ordinary cells, to which they are adherent throughout, and are irregularly distributed over the polyzoary. Occasionally they occur *at the side*. They are inferior in size to the ordinary cells. The ovicell is of the usual form.

The polypide has, I believe, about ten arms.

Dredged off Filey, on the Yorkshire coast, parasitical on *Crisidia cornuta;* not uncommon. Lamlash Bay, Arran.

Sub-order. *Ctenostomata.*

Fam. *Alcyonidiadæ.*

Sir John Dalyell, in his work on 'Rare and Remarkable Animals of Scotland,' has described and figured an *Alcyonidium* under the name of *A. Mytili*. The species has escaped the notice of Dr. Johnston, and is not included in the 'History of the British Zoophytes.' Sir J. Dalyell's description displays his accustomed accuracy, so far as it goes, but he did not observe the ovaries, and his account of the species is therefore necessarily incomplete. The name which he has assigned it is altogether inappropriate, and conveys a false impression, inasmuch as the species is by no means a parasite of the Mussel exclusively, but is found encrusting *Fuci*, stones, and shells of various kinds. It is manifestly undesirable that such names should be retained, and I therefore propose to change it. I do this with the less hesitation, because the species has thus far attracted very little attention, and Sir John Dalyell's name for it has not obtained a footing in our nomenclature.

Alcyonidium hexagonum, Hincks. (*A. Mytili*, Dalyell, 'Rare and Remarkable Animals,' vol. ii, p. 36.)

Encrusting, fleshy, of a dingy-white colour, composed of hexagonal cells, the septa of which show distinctly on the surface, and thickly covered with small obtuse prominences.

A.H. del. Tuffen West, lith. W. West Imp.

DESCRIPTION OF PLATE I,

Illustrating Mr. Hepworth's paper on the Practical Use of the Microscope.

Fig.

1.—*aa*. Exudation corpuscles.

b. The same, having undergone a slight change.

c. The same, having undergone a further change.

dd. Fully developed vegetations.

e. Crystals of oxalate of lime.

2.—*a*. *Sarcina renis*.

bb. Epithelial scales.*

c. Part of one of tubuli uriniferi.

d. Casts of ditto.*

3.—Aphthæ from a case of consumption.

4.—Ordinary aphthæ (thrush) in children.

5.—Longitudinal section of diseased intestine.

a. Thickened scirrhous peritoneal coat, the outer portion being dark brown, fibrous, and striated, the striæ being transverse to the section.

b. Outer cellular tissue containing—

cc. Blood-vessels.

d. Outer aponeurosis of what should have been the muscular coat.

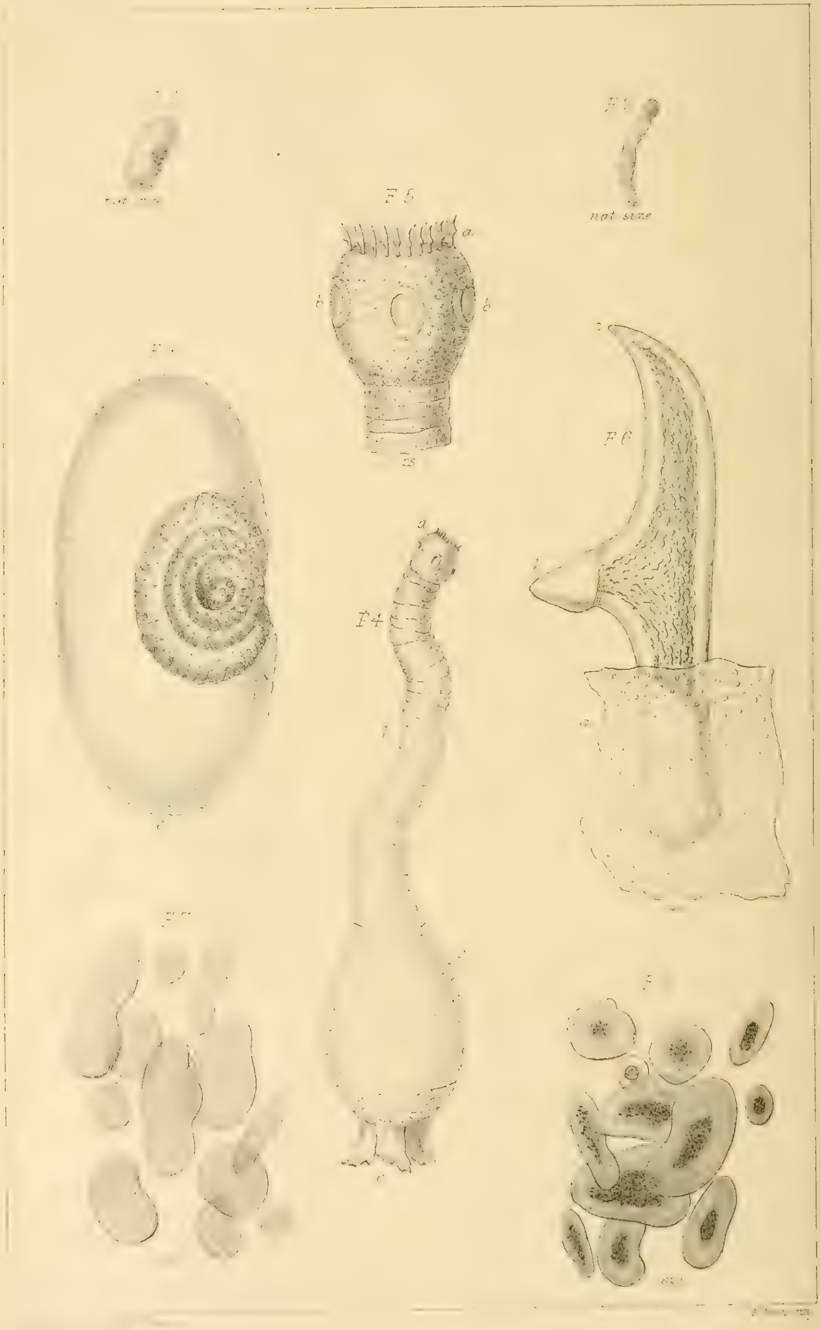
e. Cellular tissue (in place of muscular coat, which was wanting) passing at intervals through—

f. The inner aponeurosis of muscular coat.

ggg. Masses of coagulable lymph.

h. Reflected mucous membrane.

* The epithelial scales and casts were not from the same subject; it is from a drawing I took some time ago, and having often met with scales of this colour with casts, I have introduced it here.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JOURNAL OF MICROSCOPICAL SCIENCE.

DESCRIPTION OF PLATE II,

Illustrating Professor Smith's paper on Measled Pork.

Fig.

1.—The "measles," as it appears to the naked eye, taken from fresh pork.

2.—The appearance of the "measles" taken from salted pork.

3.—The *Cysticercus* and its cyst, magnified 6 diameters.

4.—The animal withdrawn from its cyst, which is broken away, magnified 6 diameters.

5.—The head of the *Cysticercus*, magnified 25 diameters.

6.—A hooklet, magnified 400 diameters.

7.—The "assimilating cellules" of a living *Cysticercus*, magnified 620 diameters.

8.—The same in a *Cysticercus* from salted pork.

DESCRIPTION OF PLATE III,

Illustrating Dr. Greville's paper on Trinidad *Diatomaceæ*.

Fig.

1.—*Cocconeis punctatissima* (a small example), showing the median line as it appears when both valves are united.

1*—The same; a single valve.

2.—*Cocconeis crebrestriata.*

3.— ,, *inconspicua.*

4.—*Campylodiscus fenestratus.*

5.— ,, *Ecclesianus.*

6.—*Surirella eximia.*

7.—*Navicula Gregoriana.*

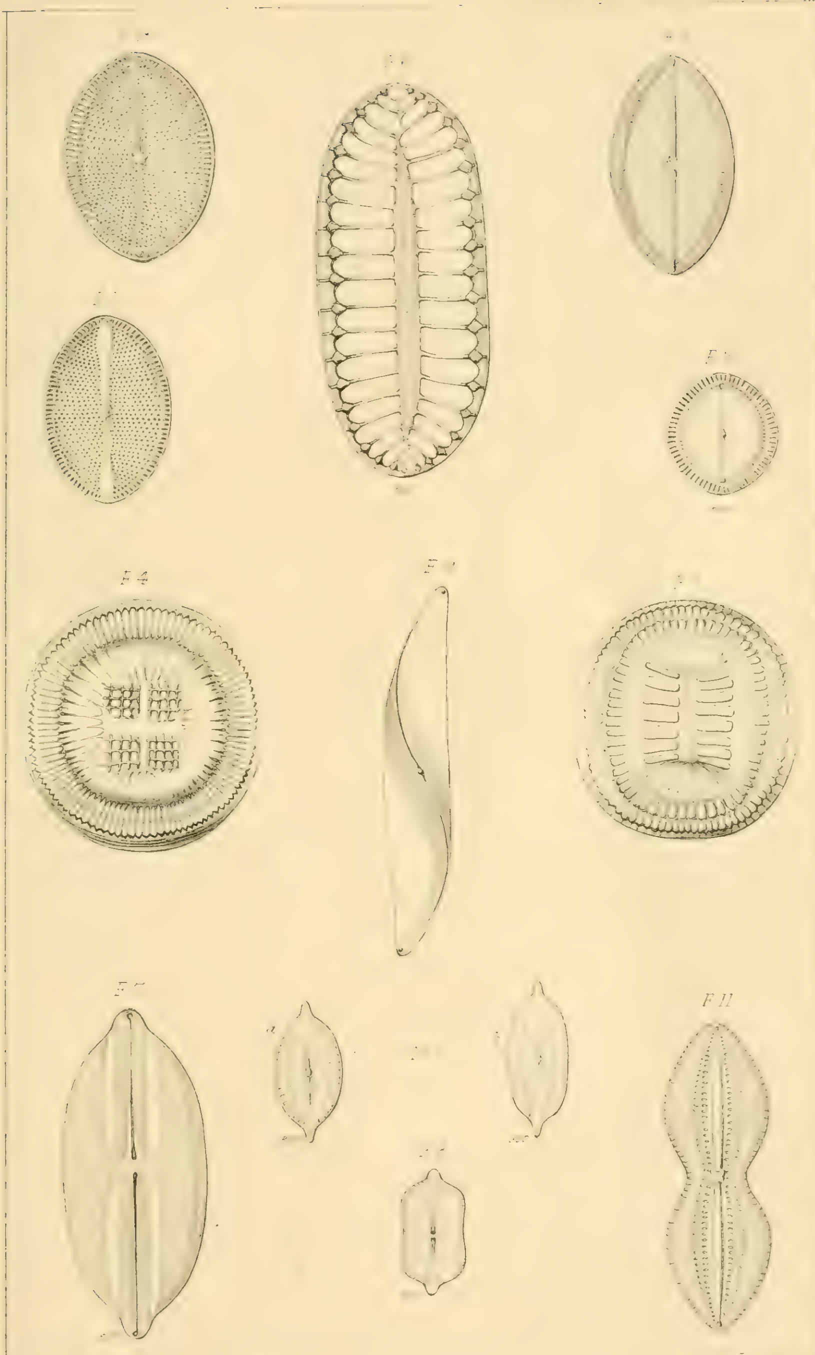
Since the description of this Diatom was printed, I have been led to suspect that it may possibly prove to be *Navicula lyra,* Ehr., as the blank linear spaces in that species seem to be very variable in their character.

8.—*Navicula compacta.*

9.—*Pleurosigma compactum.*

10.—*Mastogloia minuta.*

The scale adopted is that of Professor Smith in his admirable Synopsis, except when otherwise indicated.



R. K. G. del. Tuffen West sc.

W. West imp.

del. Tuffen West sc. W West imp

DESCRIPTION OF PLATES IV, V,

Illustrating Dr. Lindsay's paper on the Genus Abrothallus.*

PLATE IV.

Fig.

1.—Portion of furfuraceous thallus of *Parmelia saxatilis,* bearing both *Abrothallus Smithii* and *A. oxysporus.*

- *a.* *A. Smithii*—showing apothecia and intermixed pycnides. The portion of thallus on which it is parasitic differs in colour and other characters from the ordinary thallus of *P. saxatilis;* it is becoming globose from the curling of the margins and the superposition of squamules or lobes.
- *b.* *A. oxysporus* in its young state. The squamules are more flattened, or concave, and simple than those habited by *A. Smithii.*
- *c.* A young and simple squamule, bearing only the spermogones of *A. oxysporus.*
- *d.* Rudimentary, as yet sterile, squamules. The black-fibrillose nature of the under surface may be observed.
- *e.* Ordinary laciniæ of *P. saxatilis,* showing their retuse extremities and the black-fibrillose under surface.

2.—Portion of thallus bearing *A. Smithii,* magnified.

- *a.* Mature apothecia.
- *b.* Young emergent apothecia causing fissuring of the cortical layer of the thallus.
- *c.* Pycnides.
- *d.* Cyphelloid foveolæ (produced by the falling out of the apothecia) with raised dark margins. In one, the medullary tissue thus exposed is seen to be white; in the other, red.
- *e.* Black-fibrillose under surface of thallus.
- *f.* Fissure showing rusty red medullary tissue (common in Highland specimens).

3.—Section of young apothecia of *A. Smithii,* showing their mode of evolution from, and relation to, their matrix.

- *a.* Young apothecium covered by a veil of the cortical tissue of matrix.
- *b, c, d.* Young apothecia gradually emerging through cortical layer.

4.—Section, showing mature apothecia *a, b,* and foveola *c.*

- *a.* Globose.
- *b.* Somewhat deplanate.
- *c.* Urceolate foveola left by falling out of an old apothecium.

5.—Section, showing relation of the pycnides to the apothecia.

- *a.* Mature apothecium.
- *b.* Mature pycnidis.
- *c.* Young or non-developed pycnidis.

* The observations, from which the illustrations of minute structure were drawn, were made chiefly under power 380 of a Nachet's microscope.

PLATE IV (*continued*).

Fig.

6.—Pycnides of *A. Smithii.*

a. Showing the stellate-fissured ostiole.

b. Section showing cavity *b*, and ostiole *c*.

7.—Portion of thallus bearing *A. oxysporus*, mag.

a. Mature apothecia.

b. Young or emergent apothecia causing radiate-fissuring of cortical layer. The squamule is covered with a network of such fissures.

c. Spermogones intermixed with young apothecia.

d. Black-fibrillose under surface.

8.—Section, showing the relation of the apothecia of *A. oxysporus* to the matrix.

a, b. Young apothecia covered by a veil of cortical tissue.

c. Mature apothecium; flattened, resembling a plano-convex lens.

d. Mature apothecium; convex and discoid.

9.—Showing relation of spermogones to the apothecia of *A. oxysporus.*

a. Mature apothecia.

b. Mature spermogone.

c. Young or non-developed spermogone.

10.—*a.* Young apothecium of *A. oxysporus* causing fissuring of the cortical tissue of matrix, through which it is bursting.

b. Spermogones.

11.—Section of portion of apothecium of *A. Smithii.*

a. Tips of paraphyses, of a much darker brown than those of *A. oxysporus.*

b. Filaments of paraphyses.

c. Hypothecium, consisting of a brownish cellular tissue.

d. Young thecæ, full of a homogeneous or finely granular, pale or colourless protoplasm.

e. Mature theca full of nearly ripe spores.

f, g. h. Thecæ at earlier stages of development. The button-like markings of the young spores is shown at *f.*

i. Apparent membrane connecting the apices of the paraphyses.

12—Spores of *A. Smithii* in different stages of development.

a. Mature spores showing the two loculi and their unequal size, as well as the nuclei which frequently occupy them.

b. Deformities by elongation. Usually found only in old apothecia and in Highland specimens.

c. Young spores, showing the gradual division into loculi, the appearance of nuclei, and the acquirement of colour.

13.—Old spores, undergoing a process of disintegration.

14.—Paraphyses of *A. Smithii*, isolated.

a. Unaffected by reagents, showing dark brown extremities.

b. Under action of aqua potassæ, showing the terminal cells, which have acquired a resemblance to stylopores.

15.—Section of a portion of the apothecium of *A. oxysporus.*

a. Showing action of iodine on the thecæ.

16.—Spores of *A. oxysporus* in different stages of development.

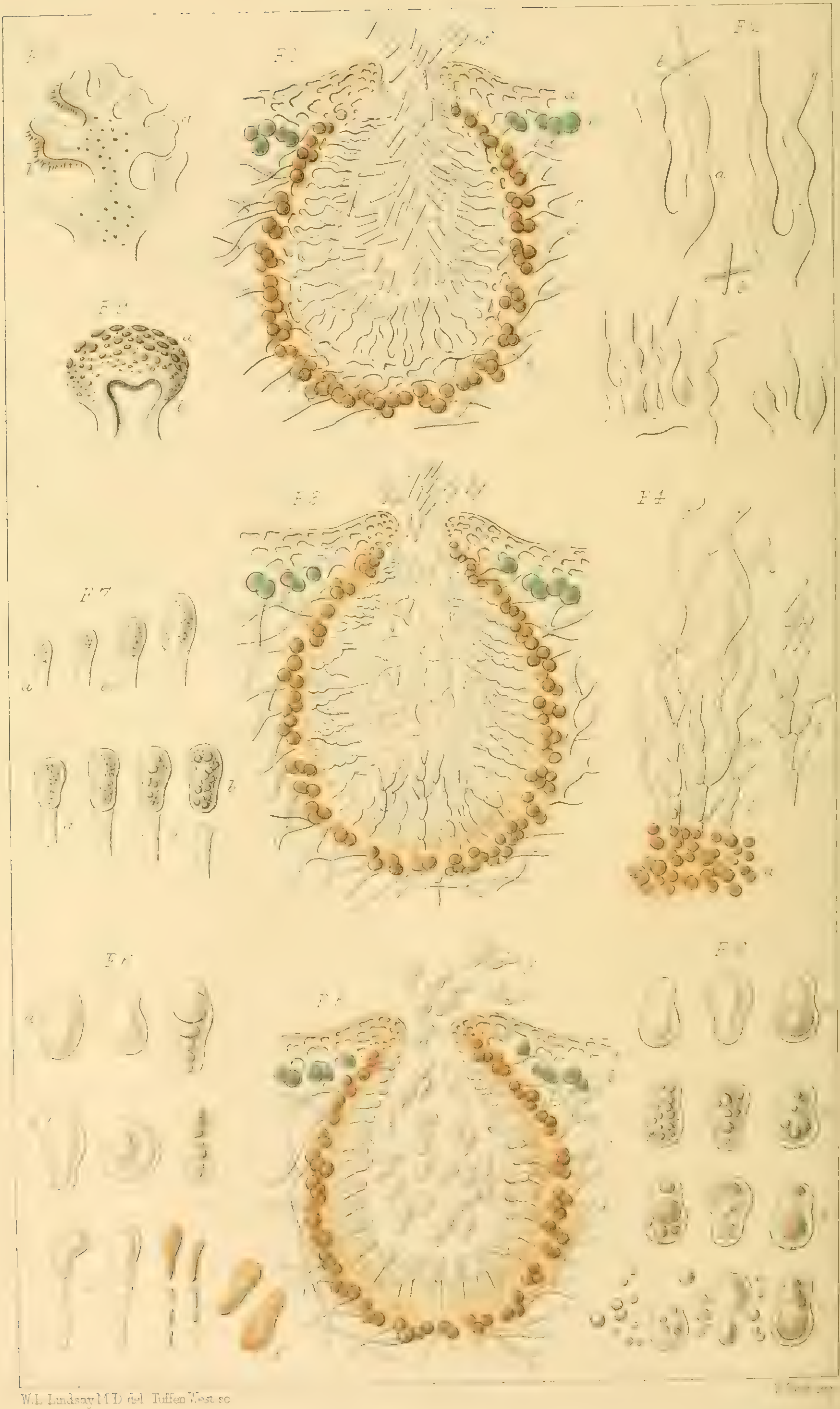
a, d. Mature spores, showing the occasional double contour and terminal nuclei.

b. Deformities by elongation.

c. Spore in process of germination.

e, f. Old spores, undergoing a process of disintegration.

g. Young spores with a granular protoplasm.



W. L. Lindsay M.D. del. Tuffen West sc.

PLATE V.

Fig.

1.—Section of a spermogone of *A. oxysporus.*

a. Cortical tissue of deformed portion of thallus of *P. saxatilis* on which the plant is parasitic.

b. Gonidic tissue of same.

c. Medullary tissue of same.

ed. Envelope of spermogone formed of a brownish cellular tissue.

. Sterigmata forming the inner walls of the spermogone, and generating the spermatia from their apices.

f. Free spermatia escaping by spermogonal ostiole.

2.—Sterigmata and spermatia more highly magnified.

a. Sterigmata.

b. Spermatia.

3.—Section of a spermogone of *P. saxatilis.* Its structure is similar to that of *A. oxysporus;* but the sterigmata are seen to be articulated, the spermatia to be generated from both sides and apices, and the interior of the spermogone to be occupied by a loose network of very delicate, ramose filaments, which spring, along with the sterigmata, from the inner walls of the spermogone.

4.—Portion of the tissues forming the spermogonal walls, more highly magnified.

a. Component cells of the brown envelope.

b. Articulated sterigmata.

c. Spermatia, which arise generally at an angle from the apices of the constituent joints or articulations of the sterigmata.

d. The ramose delicate filaments, whose anastomoses and intertwinings constitute the network of the spermogonal cavity. Some of them appear septate or articulated at the apex, where also they are generally granular and dark.

5.—Section of one of the pycnides of *A. Smithii.*

a. Cortical layer of matrix (deformed thallus of *P. saxatilis*).

b. Gonidic layer of the same.

c. Medullary tissue of the same.

d. Brownish cellular envelope.

e. Sterigmata close-set, short, delicate, forming the inner wall of the pycnidis, each bearing at its apex a stylospore.

f. Free stylospores escaping by the ostiole.

6.—Stylospores in different states and stages of development. Many of them are seen to contain large or small oil globules, or to be filled with an oily protoplasm.

a. Mature stylospores. The colourless transparent specimens are full of a homogeneous, oily, liquid protoplasm.

b. The same, from some Highland localities. The oil globules have here a yellowish tinge.

c. Shows the effects of pressure or reagents in rendering more evident the oily nature of the protoplasm. The oil globules are seen escaping from the ruptured stylospores, and many of them are floating free.

d. Stylospores of large size and irregular form from various Highland

Fig.

specimens of *A. Smithii.* Some of the specimens figured resemble certain compound or cellular spores; others might be mistaken for empty gonidia.

e. Stylospores retaining their sterigmata. They are of small size, and somewhat shrivelled. Those coloured yellow are from Highland localities.

f. Small yellow stylospores from Highland localities.

7.—Development of the stylospores from their sterigmata.

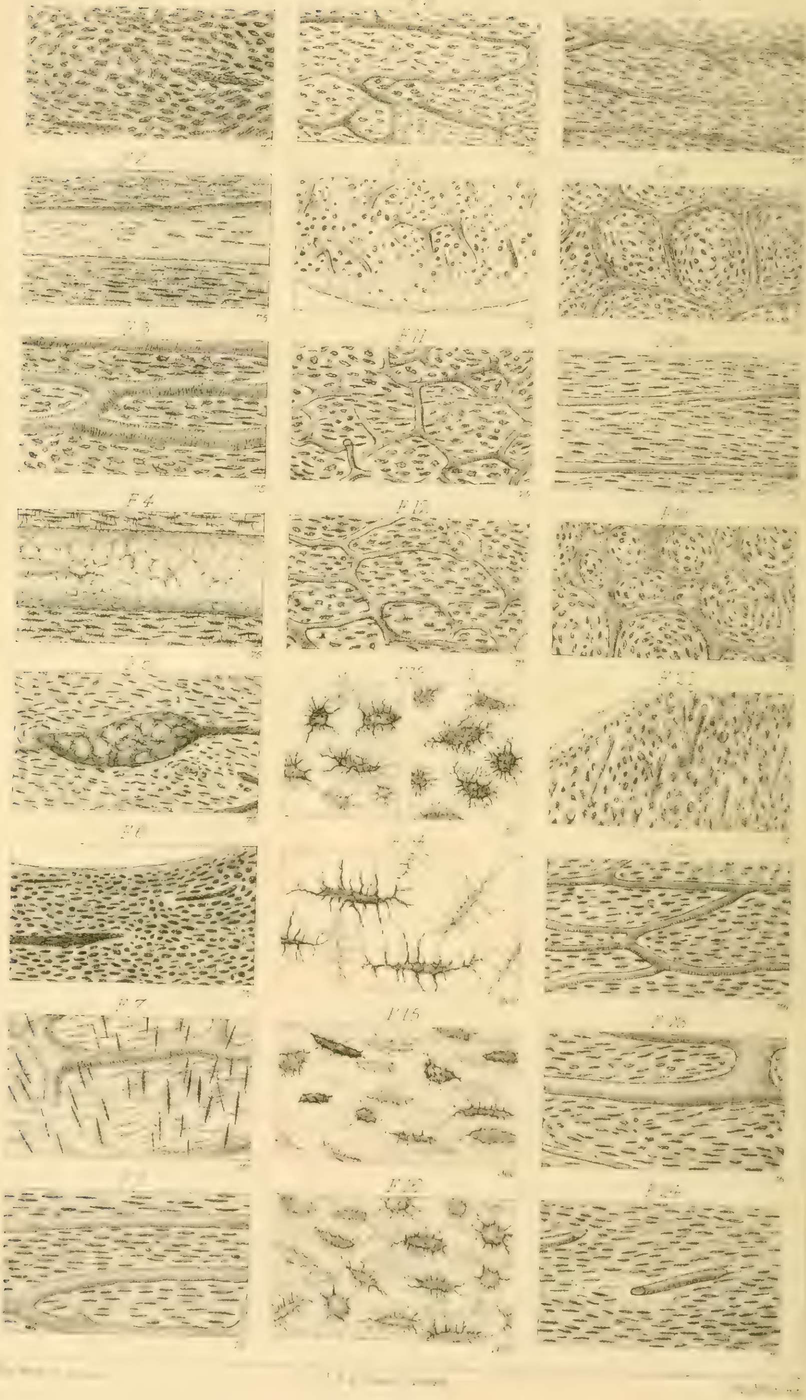
a. Sterigmata.

b. Stylospores.

The sterigmata appear first as simple filaments, with a rounded or bulging extremity; this gradually becomes dilated and separated from the sterigmata by a septum. The terminal cell then constitutes the stylospore, which speedily falls off, and for some time increases in size, acquiring more of a pyriform shape.

8.—Portion of the thalline laciniæ of *P. saxatilis,* showing the spermogones *a*, and the black-fibrillose under surface *b*.

9.—Bullose dilatation of thallus of *Cetraria glauca*, bearing the apothecia and spermogones of *A. oxysporus.* The section shows that it is hollow and stipitate.


F 4
F 6
F 7
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DESCRIPTION OF PLATE VI,

Illustrating the Rev. J. B. P. Dennis's paper on Fossil Bones from the Stonesfield Slate.

Fig.
1.—Pteropus; humerus.
2.—Bat; phalanx.
3.—Flying phalanger; tibia.
4.—Draco volans; ulna.
5.—Red-throated diver; tibia.
6.—Swift; furcula.
7.—Mr. Catt's fossil (pterodactyle).
8.—Pelican; bill.
9.—Stonesfield fossil, vertical section.
10.— Ditto, transverse section.
11.— Ditto, vertical section.
12.—Heron; humerus.
13.—*a.* Heron; humerus.
b. Stonesfield fossil; lacunæ.
14.—Mr. Catt's fossil (pterodactyle); lacunæ.
15.—Stonesfield fossil; lacunæ.
16.—Heron; lacunæ.
17.—Gannet; humerus.
18.—Ditto; coracoid.
19.—Ditto; furcula.
20.—Ditto; femur, vertical section.
21.—Ditto; femur, transverse section.
22.—Ditto; tibia.
23.—Ditto; tarsus.
24.—Ditto; rib.

* Figs. 13, 14, 15, 16, magnified 300 diameters, the remainder 75 diameters.

DESCRIPTION OF PLATE VII,

Illustrating Dr. H. Cienkowski's paper on Acineta-Forms.

Fig

1.—Transverse division of *Podophrya fixa*, Ehr.

2.—The divided *Podophrya* with the half becoming detached.

3.—The independent segment.

4, 5.—Stages towards encysting.

6, 7, 8.—Cysts of *Podophrya fixa*, Ehr.

9.—An *Acineta* with rotating embryo.

10.—An *Acineta* with the embryo escaping.

11.—The embryo, after a prolonged motile stage, becoming transformed into an *Acineta*.

12.—The transformation of the embryo into an *Acineta* completed.

The figures 1—8 are × 370 diam., 9—12 × 170 diam.

Illustrating Mr. Huxley's paper on Dysteria.

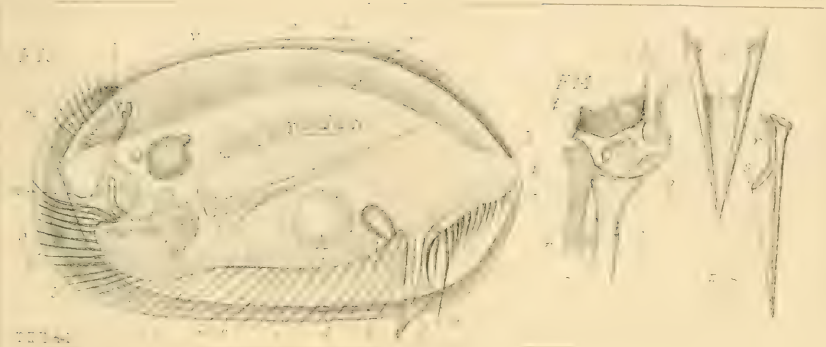
13.—*Dysteria armata*.

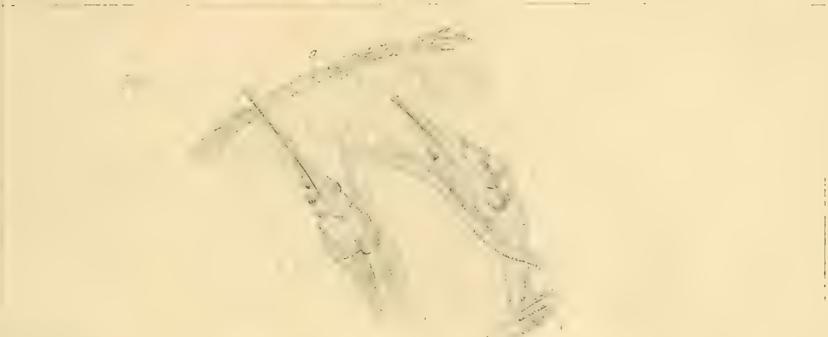
14.—Parts of mouth of ditto.

15.—Process between two styles.

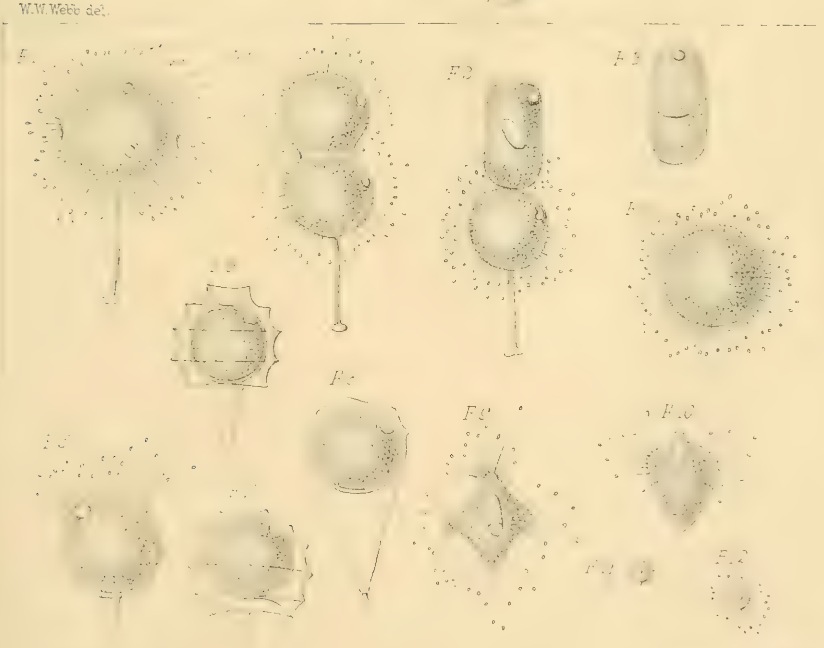
Illustrating Dr. Webb's paper on the Human Lip.

16.—Muscular fibres in skin of human lip.





W.W. Webb del.



Cienkowski del. Tuffen West sc.

DESCRIPTION OF PLATE VIII,

Illustrating Mr. Currey's paper on some points in the Structure and Physiology of certain Fungi.*

Fig.

1.—A spore of *Helminthosporium Smithii.*

2.—A spore of the same plant germinating.

3, 4.—Fragments of similar spores germinating.

5.—Fragments of two of the vegetative threads of the same plant protruding filaments similar to germ filaments. The filaments from the two upper ends have become united in growth.

6.—Spores of *Helminthosporium fumosum.*

7 to 11.—Various states of the cells constituting the so-called joints of the fruit *Phragmidium bulbosum* after their escape from the enveloping membrane under the action of heated nitric acid.

12.—The bottom internal cell and the internal stem-cell of a fruit of *Phragmidium bulbosum.*

13.—A fruit of *Phragmidium bulbosum* which has been subjected to hydrochloric acid and then ruptured by pressure, showing the escape of one of the inner cells.

14.—A similar fruit, under the action of hydrochloric acid, showing the spontaneous protrusion of two of the inner cells.

15.—A similar fruit in which the outer membrane or ascus has become swollen and separated from its contents by the action of heated nitric acid.

16.—A similar fruit, after having been soaked in water for some hours, exhibiting the internal stem-cell.

17.—A fruit of *Phragmidium mucronatum* under the same circumstances.

18, 19.—Fruits of *Phragmidium bulbosum* in germination.

20.—One of the so-called "sporidia" produced by a germinating filament of *Phragmidium bulbosum* which has become detached and commenced germination on its own account (magnified 420 diameters).

* Except where it is otherwise mentioned, all the figures are magnified 220 diameters.

Fig.

21.—Fruit of *Puccinia graminis* germinating and producing globose "sporidia."

22.—Fruit of *Puccinia Lychnidearum* germinating (magnified 315 diameters).

23. –Peculiar germination observed in *Triphragmium Ulmariæ.* (The figure only shows a portion of the germ-filament, magnified 420 diameters.)

24.—A joint of the above filament of *Triphragmium Ulmariæ* which has separated itself and commenced germination.

25 to 33.—Various forms of fruit of *Phragmidium Potentillæ.*

34.—Fruit of *Xenodochus carbonarius.*

35, 36, 37.—Spores of a species of Gymnosporium in germination.

38.—Spores of *Peziza aurantia,* exhibiting the peculiar germination referred to in the text.

39.—Spores of *Peziza aurantia* in their ordinary state.

40.—Spore of a species of Triposporium.

41.—Filament of *Zygodesmus fuscus,* showing the sterigmata at the apex. On the right hand are three spores detached.

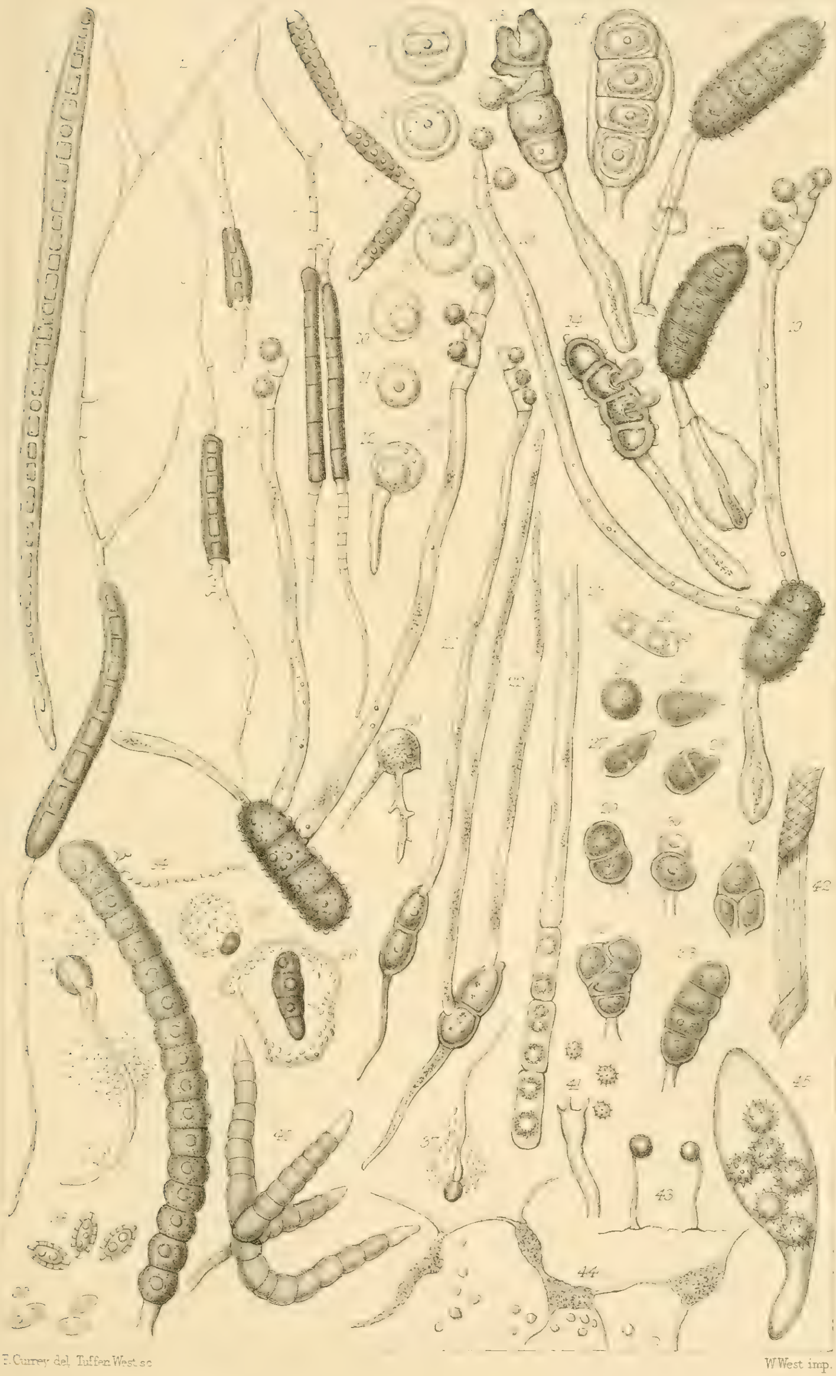
42.—A fragment of the capillitium of *Trichia turbinata* acted on by hydrochloric acid, showing the mode of spiral unrolling of the membrane and the five internal bands (highly magnified, but to no particular scale).

43.—Two specimens of a doubtful *Trichia* (slightly magnified).

44.—A portion of the capillitium and some spores of the last-mentioned plants.

45.—Ascus and sporidia of *Choiromyces meandriformis.*

46.—Sporidium of *Sphæria Amblyospora* giving out small colourless cellules into its gelatinous envelope.



F. Currey del. Tuffen West sc.

W West imp.

DESCRIPTION OF PLATE IX,

Illustrating Mr. Hepworth's paper on Compound Nucleated Cells.

Fig.

1.—Epithelial scales from kidney, after desquamation of the tubuli uriniferi.

a. Blood discs.

b. The same altered by exosmosis.

2.—Compound cells from cyst of ovarian dropsy.

3.—Nucleated cells from cancroid tumour of the brain.

4.— Ditto from forearm of an old woman, aged 83.

a. Epithelial scales.

5.—Nucleated cells from mamma.

6.— Ditto from uterus.

PLATE X,

Illustrating review of Dr. Hall's work on Thoracic Consumption.*

1.—Yellow tubercle.

a. Tubercle corpuscles.

b. Simple tubercle cells.

c. Granular matter in quantity.

d. Curled elastic tissue.

2.—Gray tubercle.

a. Elastic tissue of the air-cells.

b. Tubercle elements.

c. Compound tubercle cells, and epithelium in a state of fatty degeneration.

3.—Yellow tubercle liquefied.

a. Fluid of a creamy consistence from the centre of crude yellow tubercle. Small tubercle corpuscles, granules, and oil in a state of minute division.

b. Pus-like fluid from yellow tubercle completely liquefied.

c. Pus-cells.

d. Granule cells.

e. Columnar epithelium.

f. Oil molecules.

g. Free granules.

h. A few single tubercle corpuscles.

5.—Sputa from chronic bronchitis.

a. Pus and mucus.

b. Bronchial columnar epithelium.

c. Shrivelled and abortive cells.

d. Blood corpuscles; some of these appear to have a delicate envelope.

e. Leptomitus (a minute fungus).

5.—Gelatinous sputa, consumption.

a. Enveloped blood corpuscles.

b. Cells with a few granules, molecular matter, and oil.

6.—Flocculent sputa, consumption.

a. Pus and mucus, shrivelled cells, with irregular edges, granular matter, and oil.

b. Group of cells, with pigment; probably from one of the bronchial glands.

c. Curled elastic fibre.

* All the figures on this plate are enlarged 250 diameters.

ZOOPHYTOLOGY.

DESCRIPTION OF PLATES.

PLATE XV.

Fig.

1.—*Onchopora Sinclairii,* natural size.

2, 3.—Magnified figures of the same.

4, 5.—*Lepralia thyreophora.*

6, 7.—*Lepralia Cecilii.*

PLATE XVI.

1.—*Cryptolaria prima,* half natural size.

2, 3.—Portions of a branch.

4.—Section of ditto.

PLATE XVII.

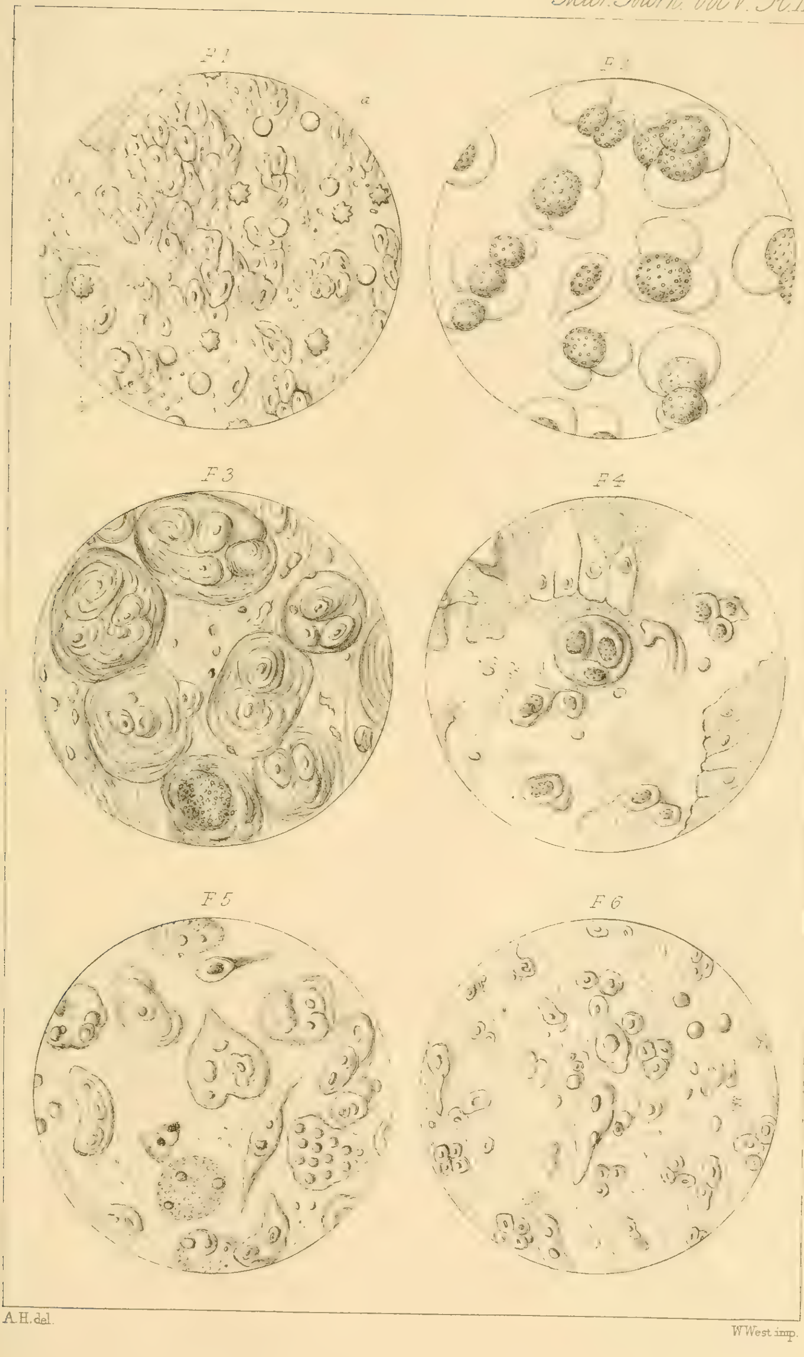
1.—*Bugula turbinata,* natural size.

2.—Front view.

3.—Back view.

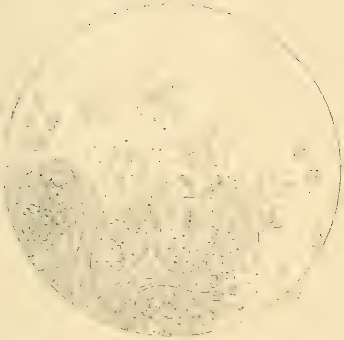
4.—Ovicell.

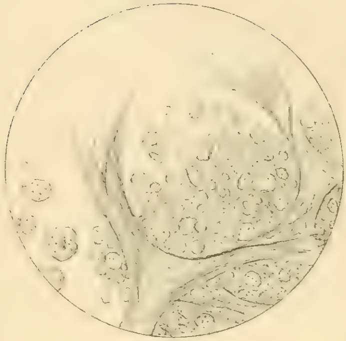
5, 6, 7.—*Scruparia.*



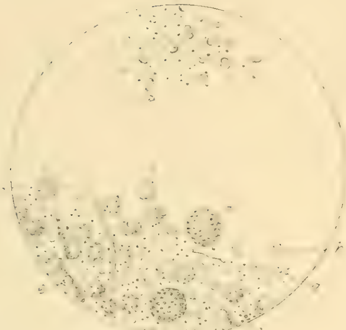
A. H. del.

W West imp.



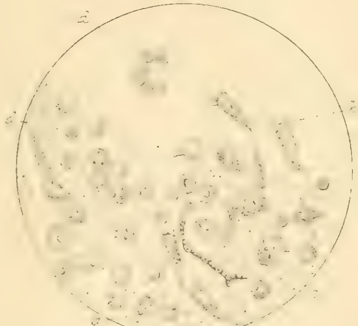


Gray Tubercle

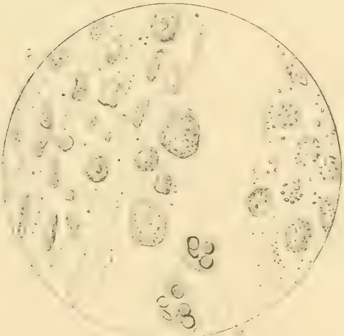


Yellow Tubercle liquefying

Fig. 4



Sputa, Chronic Bronchitis



Gelatinous Sputa, Consumption.

Flocculent Sputa, Consumption.

Tuffen West sculp. ad nat.

W. West imp.

DESCRIPTION OF PLATE XI,

Illustrating Dr. Lindsay's paper on *Lecidea lugubris*, Sommf.*

Fig.

1.—Fragment of the lichen, slightly magnified.
- *a.* Apothecia in different stages of development.
- *b.* Spermogones scattered over the squamules.

2.—Fragment of the thalline squamules, magnified, showing the—
- *a.* Apothecia.
- *b.* Spermogones.

3.—Sterile squamules, magnified, showing spermogones.
- *a.* Papillate ostiole.
- *b.* Depressed ostiole.

4.—Section of two spermogones—
- *a.* Having a papillate ostiole; and
- *b.* A depressed ostiole.

5.—Section of apothecium, magnified.
- *a.* Exciple or margin.
- *b.* Hymenium or thalamium.

6.—Section of apothecium and spermogones, showing their relative position.
- *a.* Apothecium.
- *b.* Mature; and
- *c.* Young, undeveloped spermogones.

7.—Section of apothecium, showing—
- *a.* Knobbed extremities of paraphyses.
- *b.* Filaments of ditto.
- *c.* Hypothecium.
- *d.* Mature theca: its body.
- *e.* Ditto, its pedicle.
- *f.* Ditto, ruptured, showing the mode of escape of the spores.

* The observations, upon which the drawings are based, were made chiefly under power 380 of a Nachet's microscope.

Fig.

g. Young thecæ in different stages of development.

h. Mature spores escaped from thecæ. The reaction of iodine on the thecæ, paraphyses, and spores is exhibited at *a*, *b*, *d*.

8.—Isolated paraphyses, showing the knobbed terminal cells—the seat of a dark indigo pigment—and the delicate filaments.

9.—Shrivelled or aborted spores, retaining the thecæ as caudate appendages.

10.—Mature thecæ, showing moniliform appearance, caused by distensions or bulgings of the cell-wall by the spores.

11.—Young theca, showing the development of few spores at intervals in a ribbon-like protoplasm.

12.—Spores.

a. Mature.

b. Young.

c. Old.

13.—Section of a spermogone, showing—

a. Cortical tissue of thallus.

b. Gonidic layer of thallus.

c. Medullary tissue of thallus.

d. Envelope of spermogone.

e. Sterigmata forming inner walls of spermogone.

f. Cavity of spermogone full of free spermatia mingled with mucilage.

g. Free and mature spermatia escaping by ostiole.

14.—Sterigmata and spermatia.

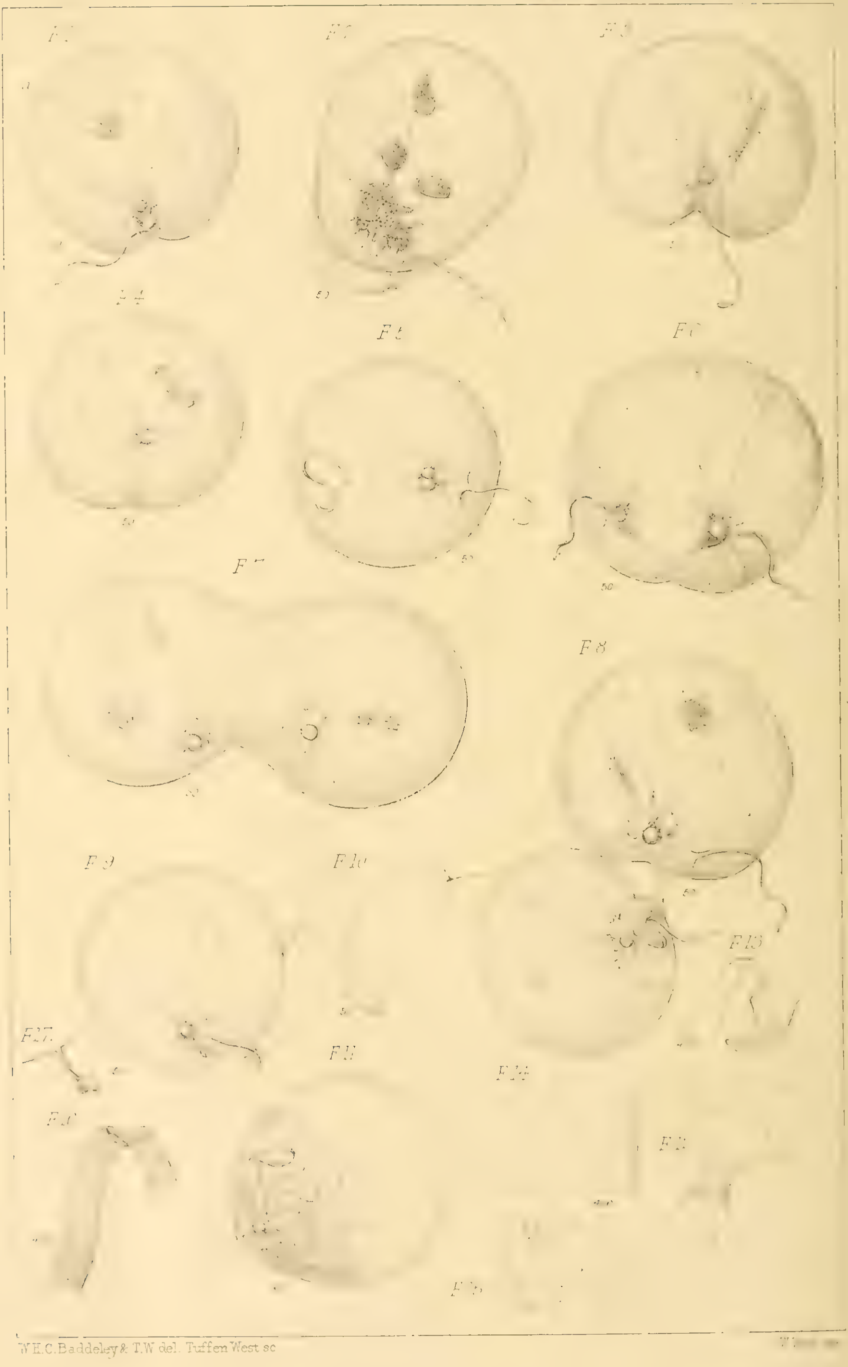
a. Spermatia.

b. Sterigmata.

15.—Sterigmata arising from articulated, thick, ramose tubes.

16.—Free, mature spermatia.

W. L. Lindsay M.D. del. Tuffen West sc.



W.H.C. Baddeley & T.W. del. Tuffen West sc

DESCRIPTION OF PLATE XII,

Illustrating Mr. Brightwell's paper on Noctiluca.

Fig.

1.—Front view, showing the tail, cilium, &c.
a. A vacuole containing a bright red-brown granular mass.

2.—Side view, showing pyriform shape, position of the fissure, &c.; structure obscure, from the quantity of food contained in the animal, a recently captured specimen.

3.—View showing the somewhat thickened angular portion; the nucleus is generally situated opposite to this, as well as the origin of the tail, so as to be indistinct in this view.

4.—Specimen in which the tail was undeveloped; most of the individuals taken during the winter months were thus imperfectly formed.

5.—Early stage of self-division: division of the nucleus has just taken place. The perfect development of the new tail at this period is remarkable.

6.—Division somewhat further advanced; the nuclei have removed far apart and a fissure is commencing. The vacuoles in this individual (which was drawn with great care) have almost entirely disappeared.

7.—Shows a further progress towards division.

8.—Shows self-division nearly complete, and two individuals now only held together by a slender cord.

9.—An individual just after complete separation and before the connecting portion is absorbed.

10.—Abnormal portion of the body thrown off by the animal, and in which no nucleus is found.

11.—Shows the effects of gentle, steadily continued pressure. At the first an appearance, as of a most delicate sac, is protruded, into which the globules, vacuoles, and sometimes the nucleus are received. The inner menbranes peel off from the cell-wall, and when the contents are out the creature suddenly collapses entirely. The appearance of the sarcode (membrane and threads) gently leaving its connections, "like threads of a very viscid liquid," and collapsing, is very remarkable.

12.—Oral orifice, &c., × 200.

13.—"Prehensile organ" and "trembling organ," × 400.

14.—Cell-wall, × 400; a tolerably thick, firm, and resisting structureless membrane.

15.—Sarcode membrane, with its thickenings, forming the immediate internal investment of the cell-wall. The thicker portions form a tolerably regular network over it; from these spring the fibrils.

16.—Tail, showing a section, × 400. This is concave in the part which comes in apposition to the body, and convex in the part which reaches beyond the body.

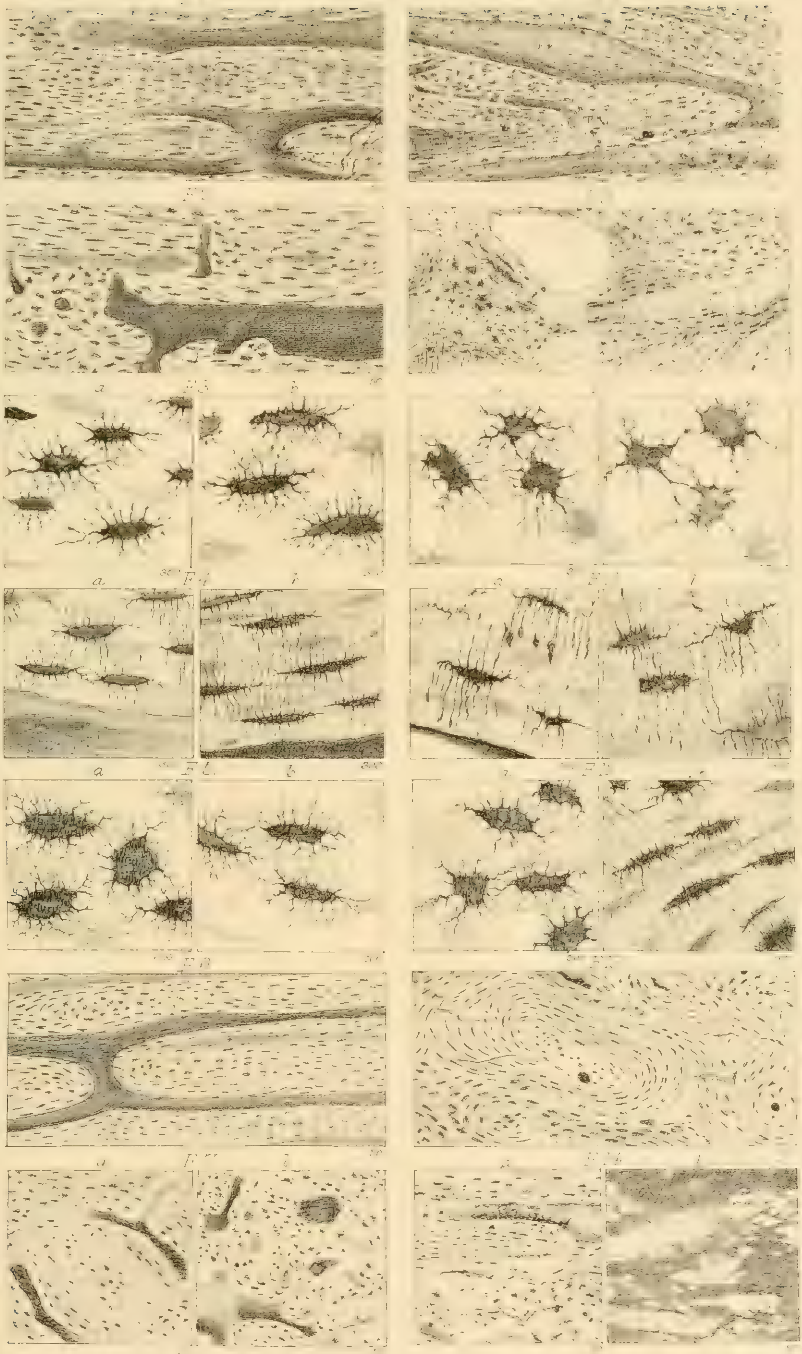
DESCRIPTION OF PLATE XIII,

Illustrating the Rev. J. B. Dennis's paper on the Microscopical Characters of so-called Cetacean Bones of the Red Crag.*

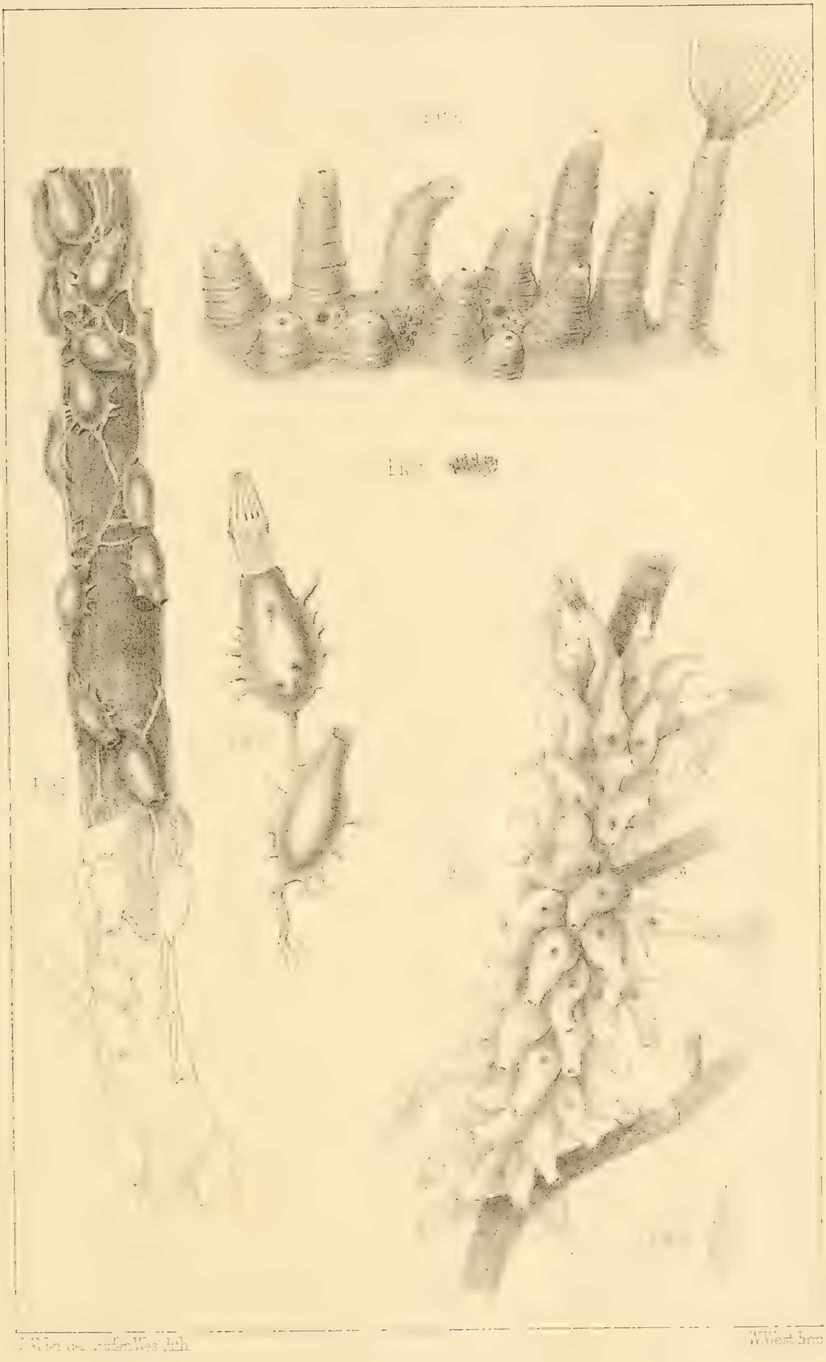
Fig.

1.—Crag fossil from detrital bed, Red Crag.
2.—Drift elephant.
3.—*a.* Free lacunæ of Crag fossil, detrital bed, Red Crag.
b. Free lacunæ of Drift elephant.
4.—*a.* Haversian lacunæ of Crag fossil, detrital bed, Red Crag
b. Haversian lacunæ of Drift elephant.
5.—*a.* Hippopotamus.
b. Rhinoceros.
6.—Crag fossil, detrital bed, Red Crag.
7.—*a.* Crag fossil, detrital bed, Red Crag.
b. Fossil elephant from Himalayan mountains.
8.—Jaw of Greenland whale.
9.—Vertebra of fossil whale.
10.—*a.* Free lacunæ of Greenland whale.
b. Free lacunæ of fossil whale.
11.—*a.* Haversian lacunæ of Greenland whale.
b. Haversian lacunæ of fossil whale.
12.—*a.* Free lacunæ of recent elephant.
b. Haversian lacunæ of recent elephant.
13.—Crag fossil from detrital bed, Red Crag.
14.—*a.* Elephant from Suffolk Gravel.
b. Decomposed recent cetacean bone.

* Figs. 3, 4, 5, 10, 11, 12, are magnified 300 diameters, the remainder 50 diameters.



J.B.P. Dennis del.



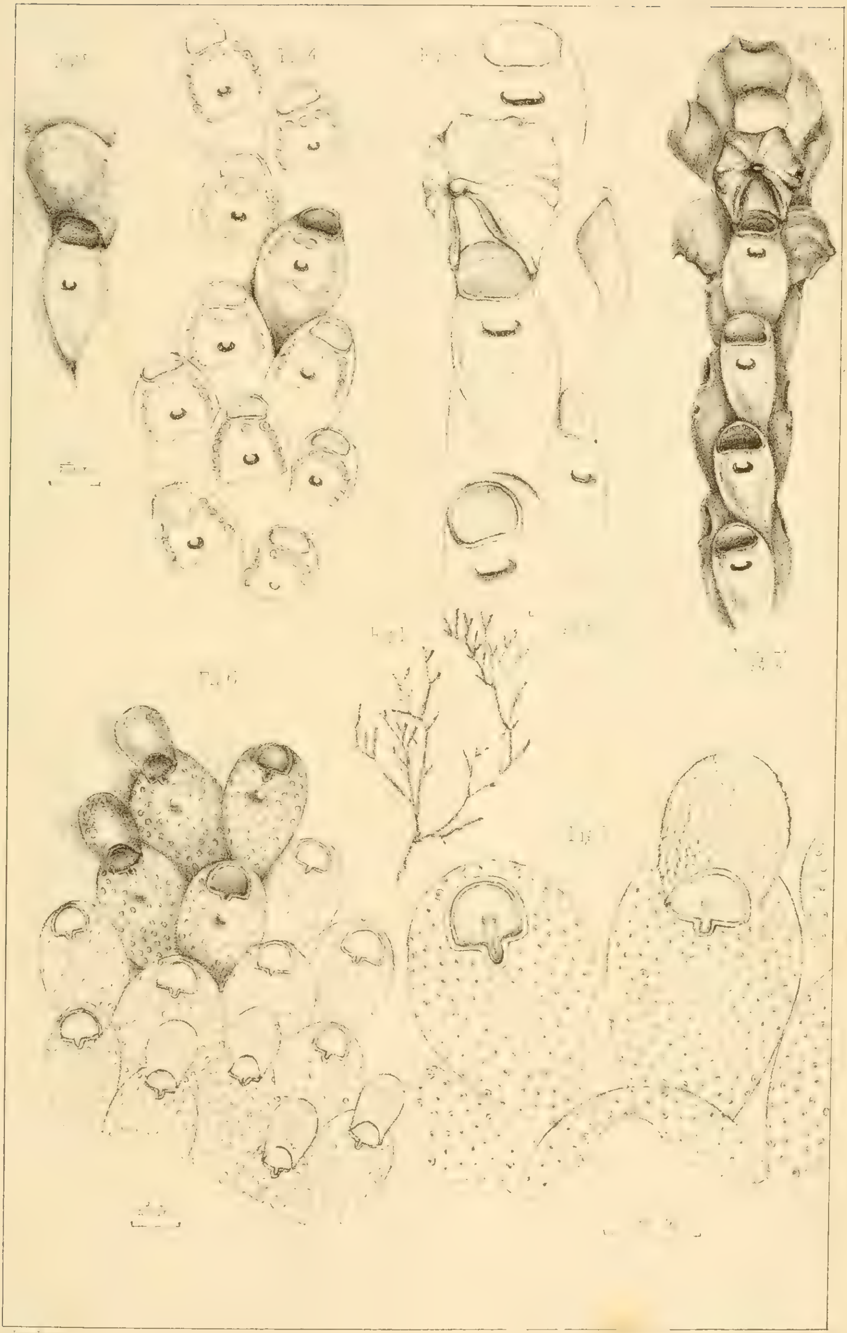
lith.

W. West imp.

Plate XIV.

W West Imp.

Plate IV



ZOOPHYTOLOGY

Plate XVI

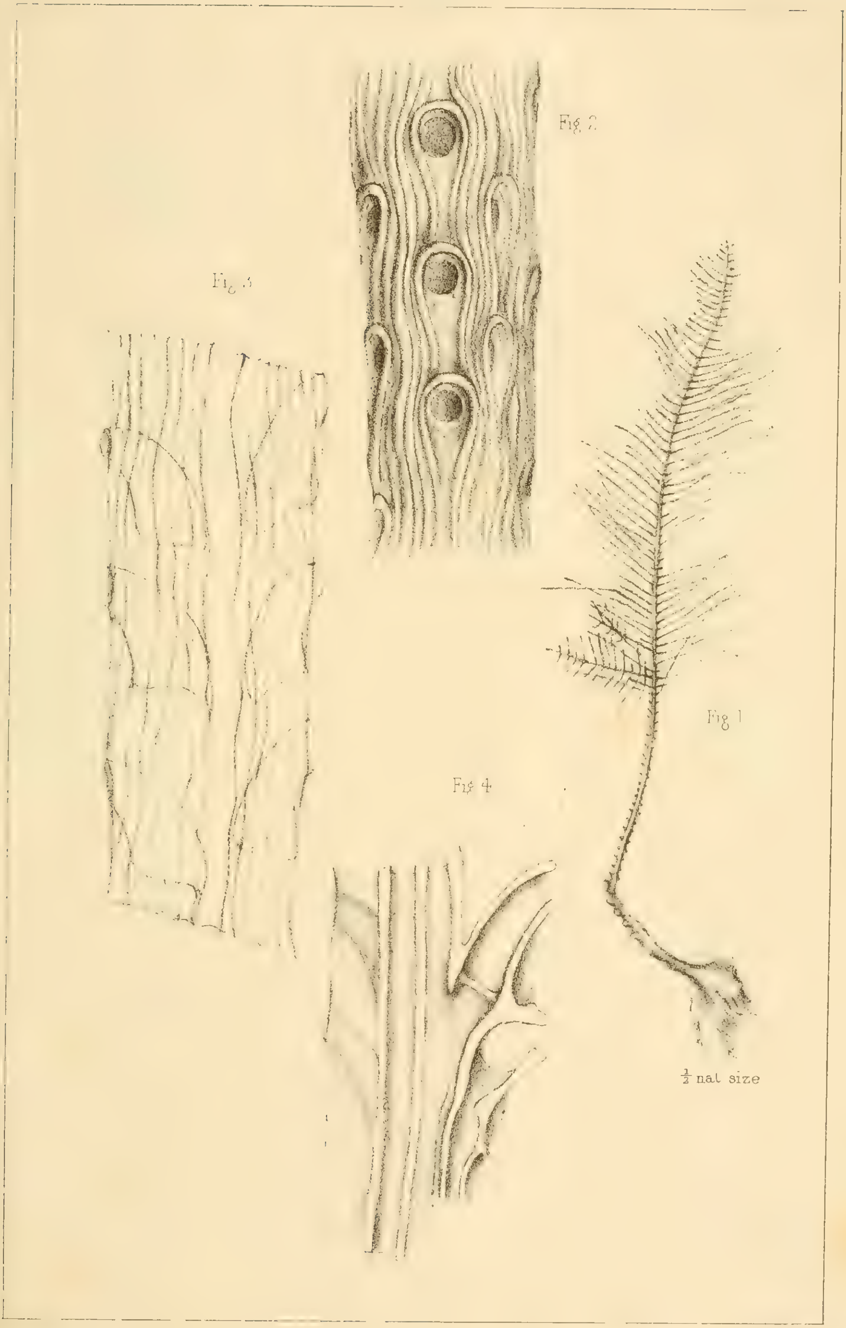


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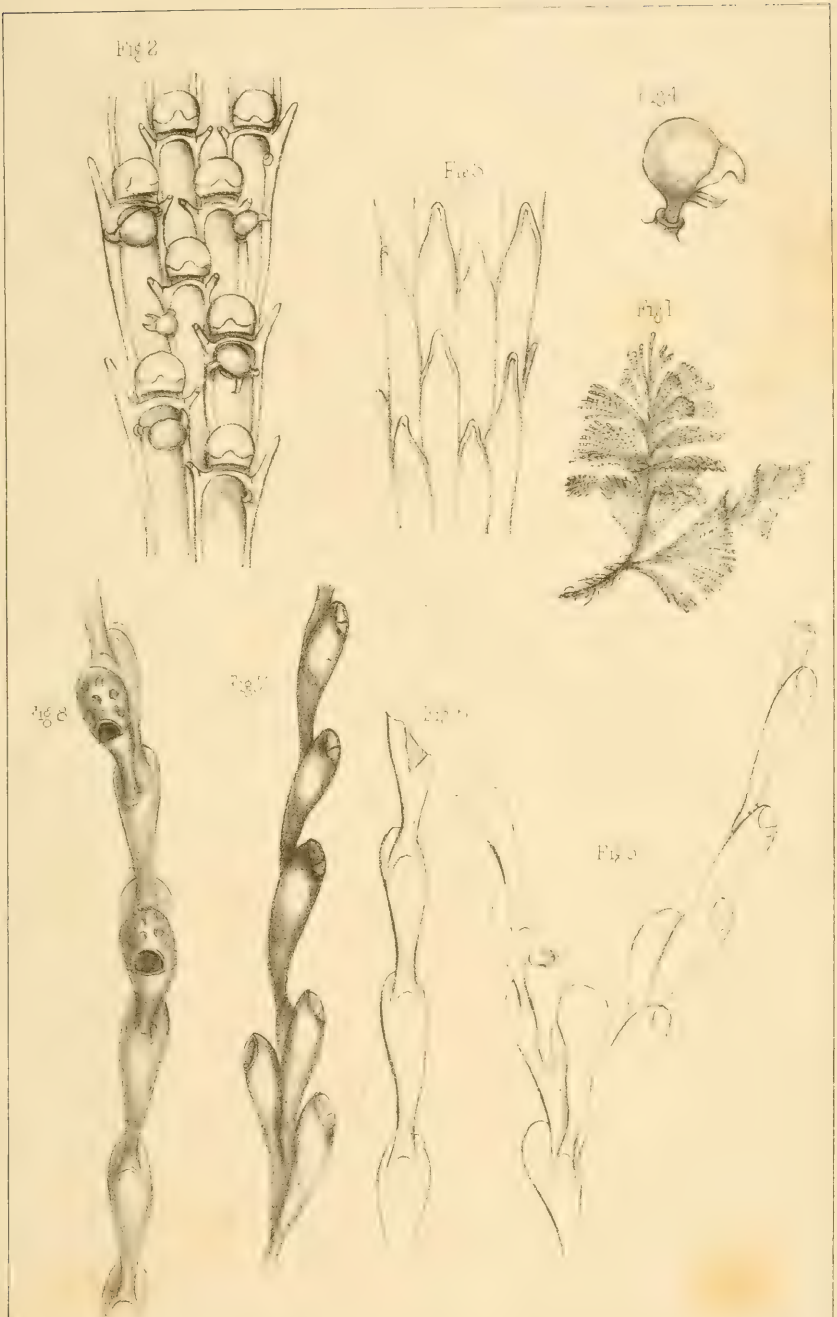
Plate XVII.



J. Alder & G.B. del.

W. West Imp.